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The STORY of MILK

1. The SOIL

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PHILADELPHIA INTER-STATE DAIRY COUNCIL
FIRST BUILDING, 112 N. BROAD STREET
PHILADELPHIA
TWENTIETH AND RACE STREETS

September 20, 1935

ADVISORY BOARD of the
PHILADELPHIA INTER STATE DAIRY COUNCIL

Dear Friends:

I am sure you will be greatly interested in the enclosed "Story of Milk" which is just off the press and ready for distribution by this Council. We think this is one of the most outstanding contributions to the literature on milk that has been made in this country for a long time, and believe it will do much to acquaint the public with many of the important steps in the production of milk and safeguards which surround the milk bottle, as well as the importance of milk as a food.

Very truly yours,

PHILADELPHIA INTER-STATE DAIRY COUNCIL

C. I. Cohee

C. I. Cohee
Secretary

CIC:jla

Foreword to the Teacher

We think of the source of milk vaguely as being "the farm" or "the cow." But beyond the cow with her definite food needs is the plant she eats. Beyond the plant with its equally definite food needs lies the soil—the source of all food.

In the soil are calcium and the other minerals necessary for our well being. But neither we nor the animals can utilize these minerals as they exist in the soil.

The necessary minerals of our own food supply are elaborated for us in a series of marvellous steps. Out of the soil which has been built up through countless millions of years, the plant manufactures from inorganic rock particles, organic food for the cow. The cow, in a second marvellous process, converts these elements into their highest form—milk.

This is the story of milk, then, through its successive phases. The subject is full of unexplored possibilities. The material is presented with as much flexibility as possible in order that the teacher may organize it to suit the needs of the individual student group.

The material is assembled under the following topics: 1—Rocks and Soil; 2—The Growing Plant; 3—The Cow; 4—The Dairy Farm; 5—Transportation and Distribution; 6—Milk, the Food. Each topic is presented in a separate folder.

PUBLISHED BY THE DAIRY COUNCIL

Rocks and Soil

THE SOURCE OF FOOD FOR THE PLANT

"Thinner than a skin of an apple is the covering of the earth that a man tills. The marvellously slight layer that the farmer knows as 'the soil' supports all men, and makes it possible for the globe to sustain a highly developed life. Beyond all calculation and all comprehension are the powers and the mysteries of this soft outer covering of the earth. For all we know, the stupendous mass of materials of which the planet is composed is wholly dead, and only on the surface does any nerve of life quicken it into a living sphere. And yet, from this attenuated layer have come numberless generations of giants of forests and of beasts, perhaps greater in their combined bulk than all the soil from which they have come."

LIBERTY HYDE BAILEY

Introduction

It would seem a far cry from a glass of creamy, rich milk back to the jagged brown boulders of some distant mountainside. And truly the journey is a long one! Long, both in the time required for the transformation, and in the centuries passing without any knowledge of the winding path which lies between.

Far back in Man's history he recognized milk as of particular value in his food supply. Groping blindly for the reason, he attributed it to a gift from the mythological gods. But the accumulating knowledge of scientists has been gradually blazing the way to the real reasons for its great food value. It is only within the space of our own generation that it has been possible to follow the path from its beginning to our own doorstep.

The soil is now recognized as the source of food for all life. In the soil are the minerals and substances necessary for the existence of the plant, the animal and even of man. By orderly processes through which the natural world functions, there exist definite steps by which the materials in the soil, products of distant boulders, undergo a series of changes in which they are made suitable food for man and animal.

The minerals, originating from rocks, are taken out of the soil by the plant, and amazingly reassembled by it in combination with elements from the air—thereby transforming these soil materials into the plant body, a form which can be utilized as food for animal and man. But a still further elaboration of these same minerals takes place. The cow, with her particularly adapted mechanism, renders the calcium and phosphorus and other soil materials from the plant into a still higher form—milk.

Thus it is that although man secures and uses freely the transformed soil materials as they are found in the body of the plant or the animal, it is from milk that these materials are available in the highest form, thereby placing milk in its unique position of being man's "most nearly perfect food."

The path through nature and science which has led up to this highest form of elaboration, represented in a glass of milk, had its beginning with nature's elements, the soil, air, sun and water.

* * * * *

The Great Ball that is the Earth

There were many millions of years while the Earth was slowly cooling from being a molten mass, that its surface was only a rocky crust, crinkling as it cooled. It was not until soil builders, working through many more millions of years, had softened this rocky surface of the earth that there could be life upon it.

The three chief builders of soil are air, water and temperature. Little by little these soil builders loosened and tore away from the hard, jagged boulders of rock, particles which were to be worn smaller and smaller, and were to accumulate through the centuries until there was sufficient foothold for the first plant life.

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Air, Water and Temperature

Air carries out its work by means of two gases—oxygen and carbon dioxide in the presence of water. The oxygen in the air unites with the iron of rocks and forms a powder with which we are familiar as "iron rust", often seen on iron implements left exposed to the weather. When the carbon dioxide in the atmosphere comes in contact with water it produces a liquid known as carbonic acid, which has a dissolving effect upon rocky surfaces, causing them gradually to crumble.

Water by constant friction, solution or solvent action, wears away rocky obstacles in its path. Rain beats down with force upon rocky surfaces. Streams and rivers are soil builders. The Mississippi River carries down into the Gulf of Mexico each year enough to cover a hundred square miles to a depth of three feet.

Temperature. The rocks expand with the warmth of the sunlight and crack. Through these cracks moisture seeps in. When the temperature falls low enough this moisture freezes and expands, while at the same time the rock itself contracts with the cold. Thus nature, through these great forces, wields a sledge-hammer which is constantly splitting and pounding the rocks nearer to becoming soil in which plants may grow.

There are other helpers of these three chief soil builders. Winds have aided, as has ice. Plants and animals make a large contribution, as roots penetrate into rocks, gradually forcing them apart, and little animals burrowing the ground make tunnel-ways by which air may enter. Even the humble little earthworm plays a part when it burrows into the earth, and, eating coarse sand particles, returns to the surface to leave these same particles ground finer by its small body.

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The Earth's Thin Layer of Soil

The soil is only a thin layer on the surface of the earth, despite the long span of time that soil-builders have worked. Directly below the soil is a second thin layer known as sub-soil. Both of these layers offer a source of food for plants although roots cannot always penetrate the hard sub-soil. After a few feet both soil and sub-soil are quickly passed, and at a certain distance the temperature of the rocks beneath begins to increase at the rate of one degree for every fifty feet. At a depth of fifteen to twenty miles the earth is still red hot. After a hundred miles the heat maintains the rocks in a liquified form.

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The Earth and the Human

The composition of the human body is strangely similar to the composition of the surface of the earth. The United States Geological Survey lists eighteen chemical elements which are found in appreciable amounts in the soil. Fourteen of these elements in appreciable amounts comprise the human body, while ten of these elements are necessary for the plant!

Fortunately for the plant and human life, nature has been lavish with these materials. Under ordinary conditions the only element of which there is any widespread deficiency is the mineral, *calcium.* "Liming" the soil overcomes this lack in the food of the plant. Feeds which are high in mineral content are being provided for the cow by the careful owner. And, as is pointed out in the foreword—for humans, milk is by far the chief source of calcium.

* * * * *

the soil, more plant food is removed in plant crops than is replaced through farm and green manures. In rotation of corn, oats, wheat and clover with timothy, it is considered (by White) that minerals may be removed to the following extent per acre during a five year period: nitrogen —60-70 pounds; potash 50-60 pounds; phosphuric acid—20-25 pounds; and calcium (lime) 30-35 pounds.

Water Drainage. Under certain soil conditions there occurs a rapid loss of plant food through drainage water, especially nitrogen and calcium. The maximum loss of plant food occurs in fallow land and in a farming system involving intensive cultivation.

Without determined efforts to counteract losses of plant food from the soil, a serious condition of soil depletion results. In fact, numerous examples of such conditions are present in the United States. Thousands of acres in this country are now exhausted of plant food through ignorance or carelessness. These lands are unable to return a living to those tilling such soil and are fit only to be turned back into forests to be rebuilt by nature.

The vast losses of plant foods such as now exist, need not and probably will not continue many years. Those concerned with the soil today are not groping in the darkness of earlier generations with scant knowledge of the subject of nutrition. We hold the information which makes it unnecessary for the food needs of the plant, the animal, or the child to go unmet. For each, the nutrition needs are clearly defined by science, but we are yet explorers in learning to apply widely our wealth of scientic knowledge.

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Note

Acknowledgment for the reading of this reference material is made to Mr. J. W. White, Professor of Soil Technology, of the Pennsylvania State College.

Pennsylvania was one of the pioneers in experimental work with soils. In 1785 a little organization—"The Philadelphia Society for Promoting Agriculture", was formed in Philadelphia, the first of its kind. Out of it grew Pennsylvania State College whose first president, with an international reputation in soil research, initiated the earliest recorded field soil experiment, using scientific control. Shortly after the crops were planted in nine experimental plots at State College, the president's assistants in the project were called away to the defense of Gettysburg.

A group of 144 one-eighth acre experimental plots at Pennsylvania State College carry the distinction of being the oldest field plots for experimenting in food requirements of plants in America.

Through the soil experiments of agricultural colleges and experimental stations, it has been found possible to so accurately determine the food requirements of certain plants that, despite their being land-plants, they may be successfully grown in water in the laboratory *because the water has been supplied in proper proportion with the minerals ordinarily secured from the soil.* These plants, because they receive an adequate diet, grow more luxuriantly than in the average soil. One of these food materials, calcium, proven to be necessary to the growth of plant, animal and man, is contributed to human nutrition chiefly through milk.

Having learned the mineral elements needed by the plant, the modern farmer has learned to "feed the soil" by liming and fertilizing it in such a way that it may furnish an adequate diet to the plant. For the functions of *calcium* supplied through liming, see next paragraph.

The basic content of commercial fertilizers is phosphorus, nitrogen and potassium.

Phosphorus encourages among other things, seed development and development of the plant root, hastens maturing and increases resistance to disease in some plants. Nitrogen influences primarily the above-ground growth of the plant, giving a deep green coloring to the leaves. Potassium aids in the development of chlorophyll (see "The Plant"), upon which the whole existence of the plant depends.

Liming and commercial fertilizers are considered an important, although not the sole measures, in "feeding the soil." Other means employed are the use of farm manure (animal waste), and green manure (plowing under crops while green).

* * * * *

Hunger in the Midst of Plenty

It is quite possible for all of the nutrient essentials of plant food to be present in the soil and yet not available to the roots. Availability is, therefore, a problem of utmost importance.

Calcium, used in agriculture most commonly in the form of lime, in addition to its own food value is outstanding in the function of making available other essential nutrients. It also promotes more normal soil health. Certain plant diseases are entirely suppressed by the use of calcium.

Calcium, (lime) is used generally as ground limestone, burned lime or slaked lime. Burned lime may be secured from the farm lime heap, or from commercial production. Slaked lime is the result of water being added to the burned lime. In some instances lime is secured from oyster shells.

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Saving the Soil

Erosion. It has been estimated (by Bennett) that cultivated fields and pastures of the United States lose approximately twenty times more plant food by erosion than by crops removed.

Removal of Plant Crops. Under conditions of nature, plant food is accumulated in the soil rather than depleted. But in agriculture where the plants are constantly being removed from

The Food that Plants Seek

The ten elements which are used by the plant are carbon, oxygen, hydrogen, nitrogen, phosphorus, potassium, calcium, magnesium, sulphur, and iron. Four other elements—baron, manganese, copper and zinc—occupy a not yet fully determined role in plant nutrition. The carbon and oxygen are chiefly obtained from the air, while the hydrogen is secured from water. All of the other elements are taken from the soil.

Four of these elements—*calcium*, *nitrogen*, *phosphorus*, and *potassium*—are actually necessary for plant growth.

It is fully as important in the growth and health of the plant that it should secure the necessary food elements in an adequate quantity as it is in the nutritive needs of the human. The needs of both are equally clearly defined. In some instances the nutritional needs of the plant and the human are identical as in the case of calcium and phosphorus, although the form available to the plant is not available to man, who can utilize these minerals only after they have been chemically changed by the plant.

Factors in making the essential foods available to the plant are not alone the chemical reactions of the minerals upon each other, but the presence of animal and vegetable organisms such as rodents, worms, insects, fungi, bacteria and plant roots.

* * * * *

Life Within the Soil

The habits of rodents, worms and some insects, which in some instances are destructive agriculturally, have in general contributed to the productiveness of the soil through pulverizing and exposing particles to the air.

A large number of different forms of fungi also aid in bringing about the decomposition of other forms of plant life. The importance of fungi has been learned more recently than that of bacteria, hence the usefulness or control of this plant form is not yet fully understood.

More information is available on bacteria than any of the other forms of micro-organisms. Bacteria are among the simplest forms of life, multiplying by dividing into half. Among the three shapes of bacteria—round, spirals, or rod-like,—the latter apparently predominate in the soil. They exist in great numbers in the surface layers of the soil where they grow in colonies wherever favorable conditions are found. Some of the types of soil bacteria have a resting and vegetative stage which permits them to exist under many otherwise unfavorable conditions. Organic matter supplies food for bacteria, which are considered far more helpful than harmful in their total effect upon the soil and plant life.

The bacteria in the soil are responsible for the continual process by which organic waste material such as leaves, is converted back into soil again, ready to furnish food to plant life.

As an illustration of the helpfulness of certain forms of bacteria, an interesting relationship exists between colonies of one form and that of the roots of leguminous plants such as clover and alfalfa (see "The Plant"). The bacteria live in the roots of the legume. The roots utilize the nitrogen made available by the bacteria which secure it from the air.

* * * * *

Experimenting With the Soil

Our knowledge of plant nutrition and of the minerals in the soil which are necessary for plant growth and health, is of recent origin if compared to the hundreds of years agriculture was practiced willy-nilly without regard to these factors. Modern knowledge represents patient experimenting carried through many years and many plant generations.

BIBLIOGRAPHY FOR FURTHER READING

(Rather than refer you to a bewildering list of references, only a few books are listed below, each of which is selected for a particular phase of the subject. Titles marked with an asterisk may be consulted in the Dairy Council library. If you cannot have access to any of the suggested volumes, your own library encyclopedia will be helpful.)

*"The Nature and Properties of Soils"—Lyon and Buckman

Macmillan, New York—1932—$3.50
(The soil, the source of all plant food. A reference book for the teacher or high school student.)

"Soils"—C. W. Burkett

Orange Judd Publishing Co., 1923
(Teachers reference, primarily on soil origin.)

"Holiday Hill"—Edith M. Patch

Macmillan, New York—$2.00
(Certain chapters on how rocks are made. For very young children.)

"How the World is Changing"

Wilcox & Follett, Chicago—$1.00
(A story of geology for ages 8 to 11.)

Rocks and Soil

THE SOURCE OF FOOD FOR THE PLANT

How cold and bare those New England rocks must have looked to the Pilgrims! Perhaps they shivered and felt very homesick when they first saw that "stern and rock-bound shore." For the Pilgrims were both sick and hungry. They needed some good food. The food on the Mayflower had spoiled. And they had forgotten to bring their cows with them.

All along the shore of the harbor were great boulders. They could not make food from those New England stones! What were they to do in this new country?

Of course America was not so new as it looked from the bobbing little Mayflower. Nature had been working on those rocks for hundreds of years. With wind hammers and rain drills; with ice levers and sun forges she toiled. Slowly the great rocks crumbled and fell apart.

Some of these stones were granite. And granite is very hard because it is a fire-made rock. But parts of granite are less hard than others. Granite is made of at least three different minerals. These are known as quartz, felspar and mica.

Quartz is very hard. Felspar is not so hard as quartz. Mica is softer than either one, but it is quite tough.

Long before there were Indians or animals of any kind in America, tiny seed engineers arrived. They helped to turn the great hard rocks to soil. These engineers worked in pairs. They were the partners, gray and green, of the very ancient Lichen Family.

Lichen and Lichen Company were the first plant pioneers. They started the very first factories in New England.

Gray was a chemist. He crumbled the rock away with an acid he knew how to make. Green ran the plant food factory and collected water. These tiny Lichens could manage on a very small amount of soil.

Gradually the quartz crumbled into sand. The felspar changed into clay. The mica crumbled too. Much of it was used by the plants as food, for mica makes good soil.

Just as soon as there was enough soil, other seed engineers arrived to start their plant factories. By the time the Pilgrims arrived there were great forests of trees.

As the leaves fell, layer on layer, they too formed a soil. This leaf mold is called humus. It is better soil than either sand or clay. The wind and snow and rain began to mix the soils together. Pure sand is not a good soil for plants. Neither is pure clay. But sand and clay and leaf humus makes loam. And loam is a very good soil for plants. Soils need much mixing. The tiny earthworms, ants and moles all help to mix the soils.

Plants need other minerals besides those that come from granite.

One of the most important minerals needed by plants and animals and people is calcium. Calcium comes from a very different kind of rock from granite. This rock is called limestone. It is known as a sedimentary rock. This is because tiny shell-like frames of small water animals settled to the bottom of the sea. Material that settles is called a sediment. So limestone made of this sediment is called a sedimentary rock.

The frames or shells of these tiny sea animals were made of calcium. Animals and people need a great deal of this mineral. One reason is because their framework is made of bones. Bones need a great deal of calcium. If they do not have enough calcium, bones are too soft. Then they bend and sometimes grow very crooked.

Now the plants can get this mineral from limestone if it is fine enough. But animals and people must depend upon the plant to get it for them. The plants mine calcium out of the soil and put it into a better form.

We cut wool from sheep. But before it is of much value it is first changed into thread. The thread is then made into cloth. And finally the cloth is made into clothes to fit us. All these are forms of wool. But clothes that fit us are more useful than wool thread.

People can eat green vegetables and get their calcium in this way. That is just the same as the cloth stage for wool. But we would have to eat great quantities of vegetables to get enough calcium. We would have to chew and chew most of the day.

But for ever so long now man has had a partner. This partner works all day long to collect enough calcium from the green plants and change it into a better form. A form that fits us like properly made clothes.

One of man's very best friends is the cow. The cow spends all day eating alfalfa and clover greens. All day she chews and chews and collects calcium from the green plants. She has four stomachs and changes the plant calcium into milk calcium. She stores this valuable mineral in her milk in the very best form we have.

The busy bee collects nectar and pollen from the flowers and changes them to honey. The cow collects minerals from the green leaves and changes them into milk.

The ordinary worker bee eats ordinary honey. But when the bees want a queen they make one. They take any little bee baby and give her better food. They change the honey and bee bread into a royal food. This better-fed baby becomes a beautiful queen. She is more graceful and even more intelligent than the ordinary bee. A better form of food made all that difference.

Just as the bees can make a better form of food from honey so the cow can make a better form of calcium from plants. Milk is the royal calcium food for humans.

It takes human babies a long, long time to grow up. For twenty-one years they need a great deal of calcium. Calcium helps to build bones and teeth. It helps to keep our human machinery running together and in good order.

Only when we drink plenty of milk are we sure of enough calcium.

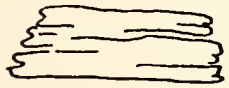
The Pilgrims would have been very happy to drink milk. Fresh milk would have made them well. But they had left their friendly red cows in England. And that was too bad. Governor Bradford was sorry he had made so great a mistake. But he sent for them at once.

Now there are enough cows in America so everyone can have a quart of milk every day. Wise Americans today will not forget their milk as the Pilgrims did. But, we should be wiser now. That was over three hundred years ago. A country could have but one King and one Queen then. Today we want all of our American boys and girls to be straight and strong and tall like Kings and Queens.

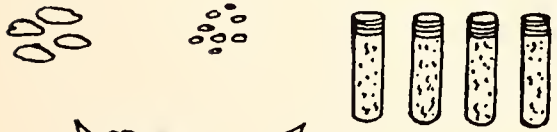
LIMESTONE, A SEDIMENTARY ROCK

Made from Tiny Sea Animals

PUDDING STONE OF SHELLS AND CLAY



LIMESTONE— (THERE ARE DIFFERENT KINDS). LIMESTONE IS CALCIUM CARBONATE



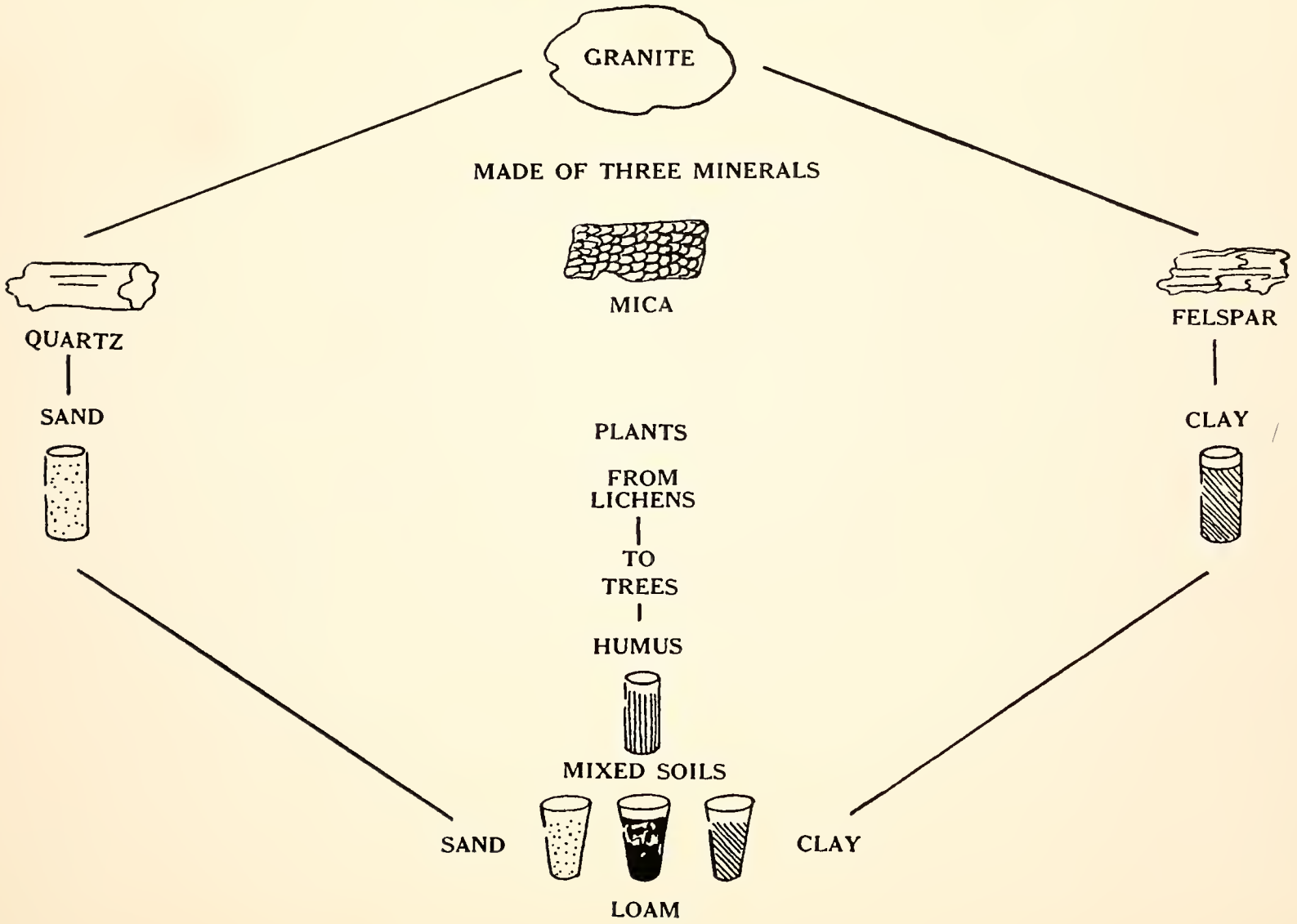
SAMPLES OF LIME

PLANTS CAN GET THEIR CALCIUM FROM LIME. LIME IS A COMMERCIAL NAME FOR A MATERIAL THAT CONTAINS CALCIUM. (CALCIUM OXIDE)

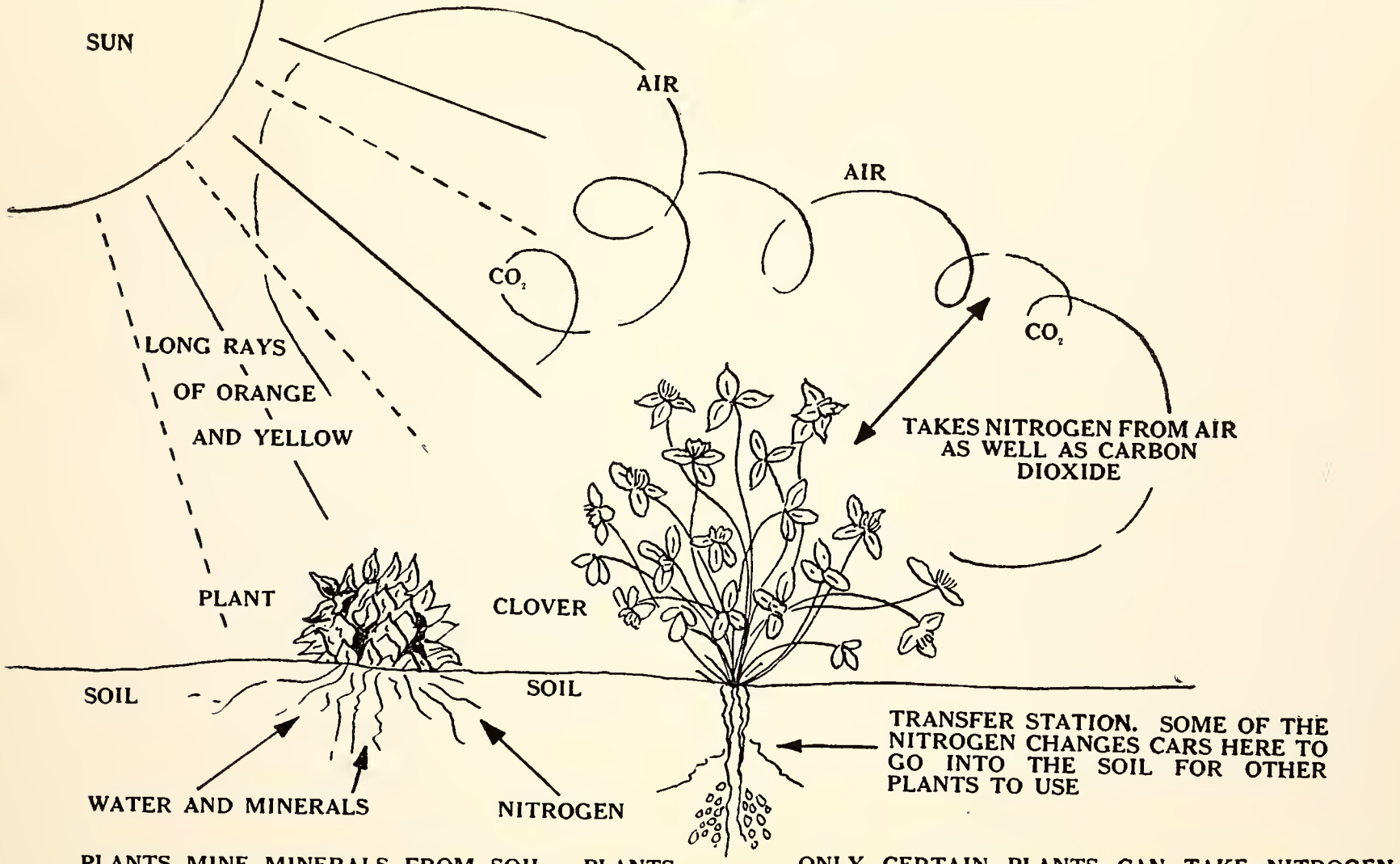
GRASS ALFALFA CLOVER

COWS USE CALCIUM FROM PLANTS. MILK CONTAINS CALCIUM IN THE FORM OF CALCIUM PHOSPHATE, THE BEST FORM OF THIS MINERAL FOR BOYS AND GIRLS AND GROWN-UPS TOO

ROCK AND SOIL



THE GREEN PLANT FACTORY



PLANTS MINE MINERALS FROM SOIL. PLANTS MANUFACTURE SUGAR AND STARCH. MAN GETS ENERGY FROM THE SUN INDIRECTLY THRU PLANTS

ONLY CERTAIN PLANTS CAN TAKE NITROGEN FROM AIR. ALL PLANTS NEED NITROGEN

SOIL IN THE MAKING

Water, freezing, thawing and wind all play a part through the centuries in breaking down rocks into soil particles.

U. S. D. A.

ROOTS ARE ONE OF NATURE'S ROCK BREAKERS

Roots of trees and plants in search of food force their way into rock crevices, thus helping to break the rocks apart and expose them to weathering.

U. S. D. A.

THE EARTHWORM PLAYS ITS PART

Many small earth-inhabiting animals and insects such as earthworms, moles and ants assist nature in soil-building.

MAN AS A SOIL BUILDER

Ploughing hastens the processes of nature in preparing the soil for the growth of plant roots.

HARROWING THE SOIL

Harrowing and ploughing are both methods of preparing the soil as a seed-bed for the farmer's plant crops.

FEEDING THE SOIL

Applying calcium, in the form of lime, to the soil furnishes this essential mineral for the plant roots similarly as the calcium in milk supplies this mineral for the human body.

U. S. D. A.

A FARM LIME PILE

Modern agriculture is careful to provide the minerals which are necessary in the soil for the best growth of the plant. Calcium, in the form of lime, is here ready to be spread on the soil.

U. S. D. A.

A LIMESTONE QUARRY

The production of calcium has become a large industry. It is used in agriculture, chiefly in the form of lime and is found in nature as limestone.

WORKING LIME INTO THE SOIL

When lime is spread over the soil it is then thoroughly mixed through the soil by harrowing before the seed is sown.

U. S. D. A.

PLANTING CORN

After the soil is carefully prepared and contains the necessary plant foods, it is ready for the seed to be planted.

U. S. D. A.

NEGLECT OF THE SOIL

Through failure to replace the calcium and other minerals which are removed from the soil by plant crops, farms may become so impoverished that plants are unable to secure food for normal growth. Heavy rains soon produce results shown above.

WELL CARED FOR SOIL

Where soil is properly cared for and continually enriched with calcium and other materials necessary for plant growth, the soil becomes more productive of farm crops year by year.

The STORY of MILK

2. The GROWING PLANT

37.1
S3s

Contents: Section II

No. 1. Forward to the teacher.
2. Condensed teachers reference material.
3. A story to read.
4. Foods direct from plants. (Table)
5. Royal food (Diagram).
Series II-1 to II-6 photos describing text

Foreword to the Teacher

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In the soil are calcium and the other minerals necessary for our well being. But neither we nor the animals can utilize these minerals as they exist in the soil.

The necessary minerals of our own food supply are elaborated for us in a series of marvellous steps. Out of the soil which has been built up through countless millions of years, the plant manufactures from inorganic rock particles, organic food for the cow. The cow, in a second marvellous process, converts these elements into their highest form—milk.

This is the story of milk, then, through its successive phases. The subject is full of unexplored possibilities. The material is presented with as much flexibility as possible in order that the teacher may organize it to suit the needs of the individual student group.

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PUBLISHED BY THE DAIRY COUNCIL

The Growing Plant

FOOD FOR THE COW

"The science which has for its object a knowledge of plants is, I do not hesitate to say, of all the subjects of natural history, that which presents at the same time the most numerous objects of utility and the most charms."

JEAN BAPTISTE LAMARCK
1744—1829

Introduction

No one would think of giving a child some pieces of stone instead of a glass of milk—and with good reason. Although the same mineral might be in the stone—should it happen to be limestone—as is found in milk, the one can nourish and build the body of the child and the man while the other cannot.

Between the two poles—the raw materials of the rock and the finished product of the milk—lie two natural processes upon which the life of man and animal both depend.

The first of these, the marvelous transformation by the plant of the raw materials into a form usable by man and animal is the subject of this section of Teachers Reference Material.

The second step, in which the cow takes these same minerals as reconstructed by the plant, and further elaborates them with other materials into milk, is the subject of Section 3 of the Teachers Reference Material entitled "The Cow."

* * * * *

Plants, Animals and Humans

Plants, animals and humans all have many needs in common. All must be born, breathe, feed and grow.

The important distinction in these needs is that *only plants are able to manufacture food directly from the soil.* Animals and humans can secure food only after the plant has manufactured inorganic matter into organic. Therefore, it may be accurately said that *all present life is dependent upon the activity of the plant world.* For this reason it is considered that plants came before animals in the history of the earth.

* * * * *

A Plant Panorama

No one knows exactly when plants, as we are familiar with them, first appeared. Fossil remains show that forms which were present in earlier geologic ages no longer exist, while those of today have since been added. The past and the present is a vast panorama of change and adaptation within the plant world. The factors of climate, soil conditions and competition during thousands of years have brought about such extensive changes in some of our familiar plants that although two families may have shared a common ancestor, they now possess but one or two characteristics in common.

It is considered probable that water-plants, possibly similar to the green jelly-like scum of our ponds, were the earliest plants. Some of this lower type of plant life was able to secure

a foothold on the dry earth. Each plant able to adapt itself to a more advanced form of land life, helped to enrich the soil and thereby make it easier for the growth of other plants.

Thus began the adaptation which has produced the myriad forms in our plant world today.

* * * * *

Kinds of Plants

As Latin was the language in which the first records of plant studies were made, it has appropriately become the international plant language, understood by botanists or agriculturists in any part of the world. Latin is, in fact, the international language for most of the sciences.

Each kind of plant is called a *species*. Species that are closely related to each other and hence have certain characteristics in common, are grouped into larger units called *genera* (singular *genus*). For a proper identification of a plant it is necessary that both the genus name and the species name be given. Usually the name of the botanist who named the species is also given in abbreviated form. Thus, the scientific name of the common pitch pine is written *Pinus rigida* Mill.; Pinus, being the genus name, rigida, the species name and Mill, signifying that Philip Miller named the species. Related genera are grouped into *families*, families into *orders*, orders into *classes*, classes into *divisions*.

There are four major divisions of the plant kingdom. These are:—I, Thallophyta (bacteria, algae and fungi); II, Bryophyta (mosses and liverworts); III, Pteridophyta (ferns, club mosses and related plants); and IV, Spermatophyta (seed plants—the highest group).

The basis of all botanical classification is credited to the famous Swedish naturalist Linnaeus and to his work "Species Plantarum", published in 1753.

* * * * *

Plants that Build Limestone

Among the lower plant forms are two types of particular interest here, namely—certain of the algae and bacteria.

One of the essential minerals important to the life of all plants and animals, including man, is calcium. This element is found in limestone and its decomposition products. Much of the limestone furnishing this valuable element has been built up by some of the green and brown marine algae. These algae secrete calcium from the water, and build of it a coating for themselves. As their bodies accumulate there is gradually built up a deposit similar to the coral formations. It is estimated (reported by Gajr) that as much as 100,000 tons of calcium carbonate is secreted annually by these algae from the water of one small lake in Wisconsin.

* * * * *

Bacteria, Our Smallest Plants

Bacteria, the smallest known plants, have a marked influence upon our everyday lives. They are present in large numbers in soil (see Section 1), where they assist in rendering organic and inorganic materials available to the higher forms of plant life. To these bacteria we owe the processes of decay by which lifeless plants and animals are returned to soil from which new plants may grow. These bacteria play an important part in the cycle of life which the Greeks represented by the "Egg and Dart" design, symbolizing "Life and Death—but not forever." Bacteria of the desirable kind also bring about the souring of milk, and in many other ways are important to man.

* * * * *

The Contribution of Scientic Instruments

The modern observer and student of the plant world, as in other fields, is debtor to the great fund of knowledge which has been built up in a real measure by the perfection of scientific instru-

or grazing cattle, would mean loss of life to some other plants. The ability of the grass plant to replace quickly its leaf factories is the feature which has doubtless enabled it to survive when other plants have failed; and this is the feature which has made it so valuable to man as a pasture for his cows.

To the large grass family belongs not only the various pasture grasses, but wheat, rice, corn, oats and about 3500 other species. No wonder it is considered the most important family in the plant kingdom, as well as the earliest plant family to be cultivated. Cows and other farm animals live upon it. It supplies the bread for many countries, and rice for the peoples of the Orient. The roots of grass form a mat over the earth which helps to protect the fertility in the soil from blowing or being washed away. And without the many forms of green grasses, how much beauty would be lost to the world.

Types of Corn. Corn is a member of the grass family, although unlike most of the other grasses its stems are solid rather than hollow. Additional roots anchor the heavy stalk which grows from two to thirty feet tall, depending upon the variety. Despite these heavy roots, a high wind will not infrequently completely flatten a field of corn.

It is the chief plant crop used for feeding the cow during the seasons of the year when other green feeds are not available in the field. Corn thus used is termed "ensilage."

The staminate flowers are born at the top of the stem (the tassel), and the pistillate flowers upon the ear, which is wind-pollinated.

The botanical name Zea Mays was probably derived from the Spanish word "maiz", as corn was found growing on the American continent when the Spaniards arrived, and is supposed to have been carried back to Europe by Columbus after his first voyage.

There are a number of varieties grouped according to the character of the ear, among them dent, sweet, podded and popcorn. Dent is the variety commonly grown for feeding farm animals in the United States. Varieties tend to mix, and this not infrequently occurs when they are planted near each other. The dent type is characterized by an indentation at the top of each kernel. The ear varies from six to twelve inches. Dent corn commonly grows to a height of from six to ten feet.

The Pea Family. The pea family of pod-bearing plants is widely distributed over the world and is considered to have been used for food far back in man's history. The word *legume*, from *legere* means "to gather" and indicates the probability that the pods were gathered long before man learned to grow and harvest crops.

The various legumes, such as clovers, alfalfa, and cow peas, are all rich in the protein which is needed in the diet of animals and man to balance the amounts used of starchy grain foods. As the roots of legumes contain nitrogeneous matter and leave vegetation in the soil when harvested, they contribute materially to maintaining soil fertility.

An interesting relationship exists between legume roots and certain soil bacteria. Colonies of these bacteria live on the roots, forming abnormal growths known as nodules. These organisms hold the power of taking nitrogen from the air. The nitrogen, which is an important element for the plant, is absorbed by the legume.

Among the leguminous plants extensively grown on the dairy farm are the field and cow peas, vetch, clover, alfalfa and soy beans.

The clovers are of special interest to the naturalist for two reasons. First, for the cooperative arrangement existing between the clover roots and certain bacteria by which the contribution to soil fertility is made, and second, because their flowers are dependent upon the bumble-bee for fertilization.

* * * * *

Photosynthesis is probably the most significant and fundamental process in the natural world. It is the chief process in nature by which energy from an outside source, the sun, is stored and made availabe for use by plants, animals and man. Directly or indirectly we are dependent upon this process for all of our food, clothing and shelter. Although photosynthesis has been widely studied by some of the world's best chemists, the exact nature of the process still remains a mystery.

Fortunately, plant life is plentiful and the artificial manufacture of sugars is not necessary. Man has been able to grow a plentiful supply of the plants which are particularly valuable to him as contributors to his own food supply or the food supply of his animals.

(For the nutrition needs of the plants see paragraph "The Food That Plants Seek" in Teachers Reference Material, Section 1, "Rocks and Soils.")

* * * * *

The Beginning of Agriculture

Primitive man lived on the fruits, nuts and edible roots found growing around him. He roamed where those wild edible plants were available. Later he acquired herds of cattle. But still, he roamed from one place to another as the supply of edible plants became exhausted.

But gradually, observing that new plants grew from seeds of old, man's first sowing of seeds began. In protecting the plants he found to be edible by uprooting those of no value, cultivation had its beginning. From a primitive wanderer, man settled down to grow those plants useful to him. He became a farmer!

* * * * *

The Plants Man Cultivates

At first man must have cultivated only those wild varieties of plants which he found growing wild about him. But it probably was not long before a selective process began, for it is known that the American Indian selected only the best corn for seed. Upon this basis and with increasing experience in selection and hybridizing (cross breeding) man has been able to encourage in cultivated plants the tendencies he desired. Thus, in a selective experiment (Webber at Cornell University) two hundred distinct varieties were selected from twenty grass plants, from which seventeen distinct new kinds were secured, which yielded a 36% larger crop than the varieties then under cultivation.

Of all the different families of plants, two great groups, the grasses and the legumes, are of importance as being the main source of food supply for the dairy cows in the United States.

The Grass Family. The importance of the grass family (Gramineae) to the entire world is so great that it has been said that "civilization of the present day is the result of cultures based on grass blades."

The blade of grass is well adapted for this important role because of its plant architecture. Some plants have spreading leaves whose need for space handicaps it in the struggle with other plants for sunlight. But the narrow blades of grass thickly crowded together at the stem, interfere only slightly with each other. In a field of pasture grasses, or on a carpet of lawn grass, the short blades frequently swayed by the air, all share in the opportunity for sunlight.

The machinery of the grass leaf operates with much economy. There are no great distances to transport raw materials as in the trunk of the oak tree, for example. In the loss of the leaf blades, the grass plant is able to put forth speedily a new set of blades without suffering any permanent injury. The complete loss of leaves to which grass is subjected by frequent mowings

ments. The *microscope* has made possible available information about bacteria. The microtome permits the cutting of a leaf as thin as a few thousandths of an inch to study its cell structure. The auxanometer measures growth, while an evaporimeter measures the plant's use and loss of water. With our modern scientific equipment each day offers new discovery in the plant world.

* * * * *

Tools the Plant Uses

Most seed plants have some form of roots, stems and green leaves. A few robber plants (parasites) such as the common dodder, do not manufacture their own food, but steal it from their neighbors.

Each part of the plant, as in the human body, has a definite function to perform.

The plant obtains the food for its first start in life from the supply stored in the seed. After the young plant is started on its way towards growth, it makes its own food out of raw materials obtained from the soil and the air.

The roots gather water and minerals from the soil, while leaves take carbon dixoide and oxygen out of the air. The stem is the corridor through which raw materials are transported. The leaves are the factory where the raw materials from the soil and the air are manufactured into a product usable by man and beast.

* * * * *

Water a Necessity

Plants, like animals and humans, must have water. No life can exist indefinitely without a water supply. Even seeds to grow must have water within. Seventy-eight percent of the weight of a clover plant and eighty percent of fresh meadow grass is water.

Little water is absorbed by the branch and leaf. The roots serve to anchor the plant, but chiefly to absorb water from the soil. This water contains various minute mineral elements, the raw food materials in solution. Solid food material can reach the plant only in solution. Hence unless the food elements in the soil are in a form that will enter into solution, the nutrients, however abundantly present, cannot be utilized.

Water, entering the roots by a process known as osmosis, is used in making sugar in the plant, in keeping the plant cells turgid, and in general, is necessary for the proper functioning of the different parts of the plant. Much of the water that enters the plant escapes in the form of vapor, which passes out through tiny pores in the leaf, called *stomata.*

* * * * *

How Plants Respire

All living cells, whether of plant or person, respire. However, plants in general have no "lungs" or special organ for respiration, but the oxygen from the air enters the cells of the plants by diffusion. Some plants do not secure their oxygen from the outside air from but chemical processes taking place within.

* * * * *

The Factory of the Green Leaf

The chief function of the leaf is to manufacture food for the plant. This work is performed by tiny cells, a hundred thousand cells measuring only one inch. Within these cells is the remarkable green coloring matter known as chlorophyll, by means of which green plants are able to combine chemically water and carbon dioxide to make sugar, one of the important foods of plants. In this process energy, from the sun or from artificial light, is stored for future use. Hence the process has been called photosynthesis, meaning literally "putting together with light."

Plants as Food for the Cow

The dairy farmer, in order to secure proper plant growth, is careful to see that a balanced supply of minerals is available in the soil for the plant crops. Therefore, in order to secure a large quantity of rich milk from the cow the plant crops he raises are selected to provide sufficient supply of the food elements in the cow's diet. (See Section 3.)

* * * * *

Note

Acknowledgment for suggestions and reading of condensed reference material on "The Plant" is made to Mr. H. W. Popp, Associate Professor of Botany, Pennsylvania State College.

BIBLIOGRAPHY FOR FURTHER READING

(Rather than refer you to a bewildering list of references, only a few books are listed below, each of which is selected for a particular phase of the subject. Titles marked with an asterisk may be consulted in the Dairy Council library. If you cannot have access to any of the suggested volumes, a library encyclopedia will prove helpful.)

*"The Green Leaf"—D. T. Macdougal, Carnegie Institute

D. Appleton & Co., New York, 1930—Price $2.00
(A laymans book of the food factory in the leaf of the plant)

*"The Garden of the World"—Janet McGill

Wilcox & Follett Co., 1930—Chicago—$1.00
(The life story of the plant for ages 8 to 11 years)

*"Botany of Crop Plants"—Robbins, University of California

P. Blakistons Son & Co., Philadelphia—1931—$4.00
(A reference book on the botany of farm crops including corn, clovers and pasture grasses)

*"The Plant World"—C. Stuart Gager, Brooklyn Botanic Garden

New York—1931

The Green Leaf Factory of the Plant

Everywhere about us today are great factories. Factories with whirling wheels that make things for man. There are factories that make furniture and rugs. Factories that make clothing and shoes. There are factories that make all kinds of different things.

Many, many years ago man had to make all these things with his own hands. He had only the strength or power of his own muscles to use. It took a long time to do everything by his own power.

Then he learned how to tame wild animals. They had stronger muscles and greater power. The oxen could plough. The horses could pull wagons. Wheels turning over the ground made it easy for horses or oxen to pull heavy loads.

Gradually man learned to use the forces of nature to help him. He used the pasture brooks and meadow streams. He made use of the wheel. Water flowing over a large wheel forced or pushed it over and over. So, as it turned over and over it moved the machinery inside the mill. The machinery in the mill had a great many wheels, some large and some small. Some turned slowly and some turned fast. The big mill wheel got its power from the moving water in the mill stream.

Everything that moves must get power from somewhere. Another name for power is energy. Without power or energy everything would stand still. Factory wheels would not move. Automobile wheels would not turn. People could not walk or run. The faster things move the more power or energy is used. The world is using more and more power every year.

Only about a hundred years ago many of our simple factories were run by mill wheels. Farmers ploughed their fields with oxen. People rode in carriages pulled by horses.

The horse became the standard by which factory power was measured. Today an automobile has as much power as sixty or seventy horses. Man's factories with their whirring wheels are becoming more and more powerful. But man could not live at all without the help of nature.

Nature had factories long before man lived on the earth. Wonderful little factories with silent and invisible machinery. Nature runs them today just as she did millions of years ago.

They do not run by magic even if they seem to. And they do appear to spring out of the earth like the Genii of Aladdin's lamp. The great power that calls them from the earth is even more wonderful than magic! For we cannot depend upon magic. But we can depend upon nature's great lamp—the SUN. It shares it's power with everyone. That is much better than giving it all to just one person.

Look out of your window some sunny spring morning! What do you see? The fields are a fresh, new green. The trees are lacy with leaves. The grass is up! The leaves are out! You may think there is nothing very wonderful about that. Spring has come. But there is something very wonderful about grass and green leaves.

Every leaf is a tiny little factory. Neither animals or people could live without these factories. The field is full of them!

Where did they come from? Who built them? Who painted them green? What makes them go? What do they make?

First of all they come from seeds. Seeds that someone planted or seeds that planted themselves in the brown soil. Seeds helped even by the birds and bees and winds. Nature's plants and animals have a happy way of helping each other.

Each seed is a tiny builder or architect. In the fall he starts out to find a place for next year's factory. He travels by air in a very modern way. Fall weather is often both cold and wet. The seed wears a good tough rain-proof coat or oilskin. The seed also carries a supply of food. This food is the kind that will not spoil easily. There is a tiny little plan folded up in every seed. All builders need a plan to follow. Human architects call them blueprints. The tiny seed plan is for building the new factory in the spring.

After the seed finds a site for the new factory he takes a winter vacation. He stops at one of nature's Field Hotels. He pulls the warm soil blankets over him and settles down for a long rest. He needs a long sleep. When he wakes in the spring he will have to work very hard.

When it is time to get up nature turns on the heat. The seed turns over. The hotel sends a shower bath. After that he is hungry. He slowly eats his breakfast and begins to stretch up and up. He stretches right up into the sunshine and fresh air. He feels just like working. Off comes his coat and in no time he unfolds his plan and builds his factory. The sun paints the factory green for him. And the tiny factory is finished.

The first rays of the sun every morning start the leaf factory working. If there is smoke or whirling wheels we cannot see them. Many wonderful things happen that we cannot see with our eyes.

Have you ever visited a leaf factory? Yes it is invisible, but that is because it is so very small. Why not become as small as Alice in Wonderland and go

exploring! Could you? Perhaps you could if only you could find that Rabbit Hole entrance. It does take imagination and study and training. But with these to help you might try.

Would you really like to visit a green leaf factory if you could?

I told you one could not depend upon magic. But science is much more wonderful than magic. It makes things happen. Now science has discovered that rabbit hole for you. When you look through it you become a tiny little watcher. Science does not call it a rabbit hole. It calls it a microscope which really means "Tiny watcher." You can see tiny things through it just as well as Alice did. You can see things otherwise invisible. Isn't that wonderful?

You will still have to use your imagination a little. The inside of a Leaf Factory is too tiny even to explore through a microscope. Though you can see what the leaf looks like inside you cannot really see the busy factory.

The wall or framework is white and lacy in appearance. The green machinery is called chlorophyll. When the sun shines down on this green machinery the factory begins to work. The machinery is run by the long red rays from sunshine. You can see that sunshine is really made of red and other colors. A prism of glass will separate sunshine into all its colors for you. The green plant machinery that runs the green leaf factory gets its power from the sun.

The ribs of the leaf are the factory water mains. Water is pumped up through them from the soil.

The plant has long mining shafts. These are long roots that mine valuable minerals from the soil. These minerals are very, very valuable. But if the minerals are not in the soil the plant cannot get them. The plant factory cannot run so well. It cannot work so well for itself or for the animals and people who depend on it for food.

Plants, animals and people all need these minerals. But only the plant factory can use them directly from the soil. Neither the animals nor the people can use the minerals from limestone or granite for food, even after these rocks become soil.

The air, the water and the minerals from the soil are the raw materials that are used by the plant factory. From these raw materials the leaf factory manufactures food. That is what plants really are—tiny food factories. Animals and men cannot make their own food. Their lives depend upon the green machinery of the leaf factories to make it for them.

The plant's own food is a mixture of water and parts of the air known as carbon-dioxide. This food circulates through the plant and feeds it. You know it very well by the name of sap. Sap is to the plant what blood is to the animal or to man.

Sometimes the plant factory changes the sweet sap into another kind of food. Sweet things spoil easily. So the sugar is changed to starch which will keep very well. One of the big store-rooms for starch made by the plant factory is the potato. When we eat potatoes we are really taking food from the plant factory's cellar or store-room. Potatoes and other vegetable foods give us the power to make us go. In fact, all the food eaten by animals and people first came from plants.

When summer ends most of the green leaf factories close. Can you think of any leaves that work all winter? A few do, but not the ones that make most of the food for man.

All the time the factory has been manufacturing food it has also been busy training the little seed builders. As you have already discovered, each seed is given a plan. Each has a tough warm rain coat. Each one has a well-packed supply of food. Each seed follows his own map or plan exactly. There are grass maps, clover maps, oat maps and corn maps. A special map or plan for every leaf that ever grew.

Some seeds are given airplanes and sail away. Others have hooks like the loggers. One way or another they depart upon their missions.

Winter comes! The tiny green machinery is silent. The factory walls turn brown. The faded little factory is closed. But what a busy season summer has been. How glad we are for nature's little leaf factories. Without them there could be no life upon this good green earth. There would be no food and the world would not be green at all.

FOODS DIRECT FROM PLANTS

(ADD OTHERS WHICH YOU MAY THINK OF)

ROOTS	STEMS	LEAVES	FLOWERS	FRUITS	SEEDS
Beets	Celery	Spinach	Cauliflower	Tomato	Beans
Carrots	Asparagus	Lettuce	Brocolli	Melons	Peas
Potatoes	Scallions	Chard		Squash	Grains
Turnips	Potato	Beet Greens		Cucumbers	Sweet Corn
Onions	Sweet Potatoes	Cabbage		Egg Plant	Nuts
Radishes		Water Cress		Pepper	Lima
Parsnips		Romain		Pumpkin	
Rutabaga		Endive		Okra	
Yams		Sprouts		Mush Melon	
		Kale		Watermelon	
				Apples	
				Oranges	
				Grapefruit	
				Plums	
				Berries	
				Pears	
				Avocado	
				Peaches	
				Strawberries	
				Cantaloupe	

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Parsnips		Romain		Pumpkin	
Rutabaga		Endive		Okra	
Yams		Sprouts		Mush Melon	
		Kale		Watermelon	
				Apples	
				Oranges	
				Grapefruit	
				Plums	
				Berries	
				Pears	
				Avocado	
				Peaches	
				Strawberries	
				Cantaloupe	

ROYAL FOOD

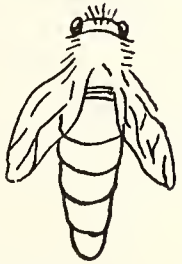
FLOWERS

NECTAR AND POLLEN

BEE COLLECTS NECTAR FOR HONEY
POLLEN SUPPLIES NITROGEN

HONEY

BY SECRET FORMULA THE WORKER BEE
MAKES ROYAL JELLY



BEES ARE BORN ALIKE

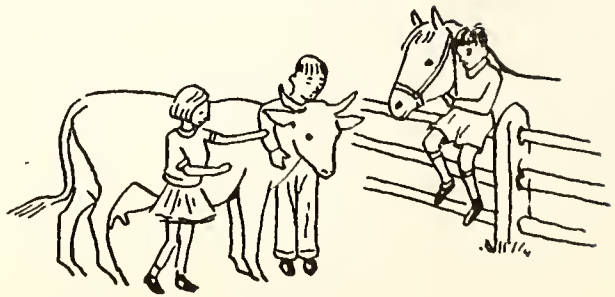
PLAIN HONEY	ROYAL JELLY
MAKES	MAKES
A WORKER BEE	A QUEEN BEE

GRASS ALFALFA CLOVER

COW COLLECTS CALCIUM FROM
HER FOOD CLOVER AND ALFALFA
SUPPLY NITROGEN

SECRET FORMULA OF COW

MAKES OVER CALCIUM FROM
GREEN PLANTS INTO ROYAL FOOD
FOR ANIMALS AND CHILDREN



SELECTING SEED

The best seed is used for planting. Corn for seed must be on large ears with well-formed kernels in even rows. The ear on the left is typical of seed corn.

CORN GERMINATING

A kernel of corn magnified, to show an early stage in the growth of the plant. A seed contains the embryo of the plant and stored-up nourishment. Note growth of stem and root.

RIES II—1
. I. D. C.

BROOKLYN BOTANIC GARDEN

ROOTS, STEMS AND LEAVES

The new plant is no sooner out of its seed coat than it begins to send down roots in search of food. Roots, stems and leaves are essential parts of most plants, each with a different function.

PA. DEPT. OF AGRICULTURE

A MATURE PLANT

A full-grown clover plant showing roots, stems, leaves and flowers. Food in the form of mineral particles in solution is absorbed by the root hairs, and travels through the stem up into the leaf, ready to be manufactured into food for the plant.

CLOVER A FARM CROP

Civilization is said to have begun when man began to cultivate those plants useful to him as food for himself and his animals. Here is shown a dense crop of clover raised as pasture for dairy cows.

SERIES II—3
P. I. D. C.

PA. DEPT. OF AGRICULTURE

BEES NECESSARY TO CLOVER

The bee carries pollen on its body from the staminate flowers of the clover to the pistillate flowers, thus enabling the clover to set seed for future crops. In Australia clover could not be raised until bees were introduced.

MANY FLOWERS IN ONE

The clover blossom is made up of many flowers which attract the bees. The weight of the bee as it alights, opens the flower, permitting the bee access to the nectar.

THE FOOD FACTORY OF THE LEAF

The leaf of the plant is its food factory. In the leaf the soil minerals are transformed by the action of the sun's rays into a form available as food to animals and humans. Upon this process all life depends.

PENNSYLVANIA STATE COLLEGE

GROWTH DEPENDS UPON FOOD

We know much today of the definite food needs of the plant, the animal and the human. Calcium is one of the most important of the minerals. The plant secures its calcium in the form of lime from limestone. Calcium is in its most available form, for the needs of the human body, in milk.

PENNSYLVANIA STATE COLLEGE

A BALANCED DIET FOR THE PLANT

Plants, like humans, attain their best development only when the minerals necessary for their growth are supplied. The result of supplying the plant crop with an adequate amount of calcium and with no calcium is shown above.

ES 11—5
I. D. C.

N. J. AG. EXPERIMENT STATION

THE IMPORTANCE OF CALCIUM

An adequate supply of calcium is maintained in the soil for the plant by the modern agricultural practice of liming the soil. Soil which has not been limed and that which has been is shown in the rows of corn above. Calcium is the mineral most likely to be lacking in the human diet.

RIGHT FOOD FOR ALL

Right food for all is the keystone of the dairy farm of today. Modern knowledge of nutrition has resulted in greatly increased production of plant crops, record-breaking milk production and most important of all, healthier boys and girls.

RIES II—6
. I. D. C.

The STORY of MILK

3. The COW

Contents: Section III

No. 1. Forward to the teacher.
2. Condensed Teachers reference material.
3. A story to read.
4. The kind of food makes a difference. (Diagram)
5. Calcium for boys and girls. (Diagram)

Series III-1 to III-6 Photos describing text.

Foreword to the Teacher

We think of the source of milk vaguely as being "the farm" or "the cow." But beyond the cow with her definite food needs is the plant she eats. Beyond the plant with its equally definite food needs lies the soil—the source of all food.

In the soil are calcium and the other minerals necessary for our well being. But neither we nor the animals can utilize these minerals as they exist in the soil.

The necessary minerals of our own food supply are elaborated for us in a series of marvellous steps. Out of the soil which has been built up through countless millions of years, the plant manufactures from inorganic rock particles, organic food for the cow. The cow, in a second marvellous process, converts these elements into their highest form—milk.

This is the story of milk, then, through its successive phases. The subject is full of unexplored possibilities. The material is presented with as much flexibility as possible in order that the teacher may organize it to suit the needs of the individual student group.

The material is assembled under the following topics: 1—Rocks and Soil; 2—The Growing Plant; 3—The Cow; 4—The Dairy Farm; 5—Transportation and Distribution; 6—Milk, the Food. Each topic is presented in a separate folder.

PUBLISHED BY THE DAIRY COUNCIL

The Cow

"Written history is short, but her (the cow) story is very long. She is an ancient of the earth, and her career is linked with the forgotten men of the Old Stone Age who pictured her in rude outlines scratched upon the walls of their cavern homes. Her minor characteristics, her size, color, conformation and function have been modified almost beyond belief. Her instincts no longer profit her, yet she still responds and acts on the suggestions of dim far-off hereditary memories."

JARED VAN WAGENEN, JR.

Our dairy cow of today has come of a long line of ancestors who trace their descent from a wild species in the family Bovidae, from which the word "bovine" has been derived. The distinguishing feature of the members of this family are hoofs with an even number of toes, and in most cases, hollow horns.

The bovine family, in addition to cattle, include sheep, goats, musk oxen, antelope, bison, mountain sheep, mountain goats and many other members. The deer family are closely related to the Bovidae, but have solid branching horns which are shed annually.

The two ancestral species of the domesticated cow in this large Bovidae family are Bos Taurus, European cattle, and Bos Indicus, the humped cattle (sometimes called zebus) of India and Africa.

The bos species is divided into five sub-groups as follows:—

1—*Bibovine*—A humped form of cattle, native of southeastern Asia. Includes the quar gayal and banting, specimens of which are to be seen in some natural science museums.

2—*Leptobovine*—Now extinct.

3—*Bisontine*—Includes the European and American bison and the yak.

4—*Bubaline*—The buffalo group.

5—*Taurine*—Includes the forebears of our dairy and beef cattle and the humped cattle of Africa and Asia.

Prehistoric drawings on rocks give us our only knowledge of the early wild cow, for domestication had already taken place before our earliest records of man himself. Such drawings have been found in South Africa which show cattle somewhat similar to the trek oxen used by the Boers. In India, specimens of an extinct ox have been found bearing a relationship to the bison type. In Turkestan where much has been learned of the oldest civilization of which we have record, remains of another species of wild ox have been found.

The ur, a wild ox, roamed in great numbers over western Asia, northern Africa, and the European continent. It is believed to have lived within historic times, and was described by Caesar as inhabiting the forests of the Rhine.

Until fuller knowledge of prehistoric times can be secured from geologic records, the roots of the family tree of the cow are a tangled skein of many types, blended in the great migrations of prehistoric wandering tribes which swept from Asia over Europe.

The nearest surviving kin to the prehistoric forebears of the cow are the Wild White Cattle of Great Britain. A few herds still exist at Chellingham Park in England and in Cadgow Forest, Scotland.

* * * * *

The Cow Through History

Far back in the Old Stone Age, early man had domesticated cattle. Geologic findings show a domesticated long-horned ox dating back to about 8000 B.C. In the polished Stone Period, when man in Europe was only emerging from savagery, invasions of Asiatic people are believed to have brought domesticated animals, including cattle, with them. When man advanced into the Bronze Age, domesticated plants and animals had become prevalent.

For a time nomadic man accepted the wild types quite as he had found them. Roving tribes either followed the cattle from place to place, or guided the cattle in the direction of grass. A primitive tribe in Asia still accomplishes the prodigious feat of annually crossing a high mountain range, with their cattle and possessions, in the search of grass for the herds.

When man became a settler instead of a nomad, it was necessary to supply to the herds the food for which they had previously foraged.

The introduction of tame grasses into Italy in medieval times gave some assurance of winter feed for cattle to many European countries. When Marco Polo travelled through Asia in the middle of the 13th century he found dairy products and "cattle of every kind, well-sized, fat and exceedingly handsome." The invention of gunpowder in the 14th century offered protection against wild animals and thus increased the herds. But the feudal system of Medieval Europe with its depressed morale and low standards of living offered little encouragement to the general improvement of the herds of cows.

The Vedic hymns of India tell of the early pastures of Central Asia where the word "king" or "warrior chief" was "gopatis", meaning "Lord of the Cows."

In the early Greek and Roman civilizations the herd became elevated to a position of religious reverence. The gods were propitiated by the sacrifice to them of the choicest member of the herd.

In Egypt, the herds were not merely sources for food, but were crowned with wreaths and paraded in religious celebrations. Both the Hindus and Hebrews insisted upon the humane treatment of the ox. To the Hebrew patriarch, wealth was measured largely in terms of herds. The Roman word *pecunia* (money) was derived from *pecus* (cattle).

The Roman historian in writing of the Punic Wars describes an important role once played by the ox. He wrote "Two thousand oxen, with lighted pine torches tied to their horns, were driven into the hills at night, thus presenting the appearance of a moving army." The Romans, thinking the enemy was escaping, attempted to block the way only to discover that Hannibal's forces had meanwhile escaped by an unguarded pass.

As inhabitants of various areas of the continents gradually acquired distinctive characteristics, so also did their cattle. In ancient Greece there were white cattle in Thessaly and hornless cattle in another section. Each Roman province had its type of cattle.

There were two breeds of cattle in ancient Scandinavia; one, a small hornless, possibly spotted, breed, and the other a large-horned yellow or red type. The first inhabitants of Holland who had originated from central or western Asia brought with them some white cattle. It is considered that cattle were brought to England from Italy by the Roman conquerors. The Wild White cattle in England today, referred to in a preceding paragraph, resemble the early Roman breeds.

The Vikings carried their cattle with them on their voyages, and it was likely that Thorfinn Karlsefne, the Scandanavian who founded a colony in America, carried cows on shipboard.

There is nothing to indicate the existence of cattle having been discovered by the early explorers of the American continent. Bison were the only bovine animals seen by the Spaniards,

although Coronado, in writing from Spain of his journey up from Mexico through the West, said that "the cows are as numerous as the fishes of the sea." These cows were the American bison.

Cattle were first introduced into Mexico, and then driven north into California and Texas. DeSoto supposedly left cattle and horses in the West where his expedition was abandoned.

Colonial history gives more definite information of its period. The early settlers arrived without cattle, and the Indians had no domestic animals except the dog.

The first cattle arrived at the colony at Jamestown in May, 1611, and were partly from England and partly the black Spanish stock. The Plymouth colony was three years without cows, but in 1624 cattle were shipped from Devonshire, England on "the good ship Charity." The Dutch settlers of Manhattan in 1625 brought with them cattle which presumably were the black and white Fresian breed from near the coast of Holland.

The Pennsylvania settlers secured most of their cattle from the earlier arrivals of Swedes along the Delaware.

The cattle in the various colonies soon became mixed, losing their characteristics. Furthermore, the settlers had neither adequate labor nor time in which to erect proper protection against weather, nor to provide shelter and food. During those first winters, before even the scythe was in use for cutting hay, many of the cattle died of starvation. As a result of these conditions of malnutrition and inadequate care, the actual size of the cattle during the colonial period became smaller. Despite these early conditions, the number of cows soon increased rapidly.

It was from this point onward that in both Europe and in the United States improvements in the type of cattle became greatly accelerated, and we find the cow type in the United States dividing itself into two branches, i.e. a type for the production of milk and a type for the production of beef.

* * * * *

The Development of the Dairy Cow

It has been said that "the cow in her present state of development is the result of centuries of cultivation and care with excellent breeding at intervals and much neglect the remainder of the time." The fine cattle which occasionally appeared prior to 1800 were largely the result of chance, with the benefits more often than not lost to succeeding generations.

It was not until the production of milk became a specialized form of agriculture in this and other countries that any consistent projects in developing a particular type of cow took place.

In the United States conditions favorable to a special type were brought about at an early period in the history of the country. With the coming into use of the railroad about 1850, the driving of the cattle on foot from the west and south to market in the east received a check. Beef cattle raised at a lower cost in the west could arrive by rail, fattened and ready for the eastern markets. This discouraged the east in the raising of cattle for beef purposes. On the other hand, the nearness of the farmers in the east to the growing industrial cities resulted in a promotion of dairy farming and in efforts to develop a type of cow especially adapted to the production of milk.

The dairy cow of today has resulted from a method of breeding begun by Robert Bakewell, a farmer in England. His method, which was first applied to beef cattle, was that of consistently selecting only the individuals with the most desirable characteristics to produce the next generation. The scientific theories of "inherited characteristics" which were being set forth by Darwin, Mendel and others, gave added belief to the value of such experiments. Since that time, the theories of Darwin and Mendel have been so conclusively proven as to be now accepted as a natural law. So much additional knowledge has since been acquired that results of breeding

along certain lines are predictable, whether applied to plants or animals. Through selective breeding the type of the cow has been more greatly changed during the past two hundred years than during the preceding two thousand years.

A prerequisite in this method of selective breeding is that the qualities which are the desirable ones shall be understood, and that the score of each cow in measuring up to these qualifications shall be known. Consequently, one of the first expressions of the growing interest in the development of a dairy type of cow was the formation of agricultural organizations for this purpose. One of the first agricultural organizations was "The Philadelphia Society for Promoting Agriculture", which aided in giving impetus to the movement in Pennsylvania. A number of importations from Europe of the best stock of cattle then available were made into Pennsylvania by such early breeders as Colonel John Hare Powell and others.

Gradually, cow-testing associations and cow registering associations have grown up throughout the United States, encouraging the dairy farmer in ascertaining the production record of cows, and in maintaining so-called pure-bred dairy cattle which would meet the requirements for registration.

As a result of two hundred years of continuous selective breeding our present dairy cow has lost even the traces of her early large-framed ancestry, when the quest for food and water permitted her to produce only enough milk for the needs of her own young. Today the dairy cow is beautiful in form, with her whole organism centering about the milk-producing function. Within twenty-five years we have seen the records of a quarter of a century ago doubled and then trebled.

The largest milk record is held by Segis Pietertje Prospect, whose world record was 37,381 lbs. of milk or 4,366.6 gallons in one year.

The four numerically largest breeds of dairy cows in the United States are the Ayrshire, Guernsey, Jersey and Holstein.

* * * * *

The Famous Four Breeds

THE AYRSHIRE—The Ayrshire was developed to fill the need in Scotland for a dairy cow. Farmers of Ayr in southwestern Scotland crossed native stock with other breeds. The Ayrshire is now popular under widely different climatic conditions, from the tropics to the Arctic.

The Ayrshires reached America through importations from Canada over 100 years ago. The first recorded importation was that of the Massachusetts Society for the Promotion of Agriculture in 1837. New York now leads in Ayrshires, having approximately one-third of the total number in the United States within the state.

The average weight of the Ayrshire cow is around 1000 pounds, and in color the type is white with a little red about the head and neck and a few spots scattered on the body.

The Ayrshire Breeders Association has done much to increase the popularity of the breed through advanced registry testing for outstanding individual production records. This was the first breed association to establish a method of testing called the Herd Test, which includes all cows in the herd.

THE GUERNSEY—The home of "The Golden Guernsey" cow is a small island, only 24 miles square, in the English Channel. The Guernsey is generally accepted to be a cross between the large red cattle of Normandy and the small yellow cattle of Brittany, made by the inhabitants of French descent on the Island. The Guernsey breed, to which the Island chiefly owes its fame, is considered to be a triumph of community cooperation. The efforts of the entire island were directed toward the production of a quality breed.

Cattle from the Isle of Guernsey first reached the United States more than 100 years ago, and were placed on Cow Island, New Hampshire, where this first importation stock was kept pure. In 1881, S. C. Kent and some Quakers in Chester County, Pennsylvania began to make importations for public sale, where they were placed largely on estates surrounding Philadelphia and other cities.

The Guernsey cow is fawn colored, marked with white and is larger than the Jersey breed. The Channel farmers stress the relationship between the color of the skin and the yellowness of the milk product. The American Guernsey Cattle Club is the official organization for advancing the achievement records of the breed.

THE HOLSTEIN-FRIESIAN—The Dutch were among the earliest breeders of cattle. To them we owe the origination of the popular Friesian breed, noted for its large size and capacity for high milk production. It is believed by some that the early cattle of the Friesians were descended from one of the wild types of cattle inhabiting the forests of north central Europe.

When the Dutch arrived at New York they brought with them their Friesian cattle, although these were probably later displaced by British cattle when the New Netherlands were ceded to Great Britain.

Importations of Dutch cattle in which records were maintained took place around 1860 at a time when the dairy industry in the United States was expanding. The breed became widely popular, and is numerically the largest in most of the dairy sections. Breeders and owners of Friesian stock were the first group to form an advanced registry system similar to that now used by all breeds. In appearance, the Holstein-Friesian, as the breed is termed in the United States, is usually spotted black and white, although occasionally red and white. The cows are large in size, with slender necks and small incurving horns. The Holstein-Friesian Association is working towards continued improvement of the breed.

THE JERSEY—The Jersey breed has been developed by the people of the small Isle of Jersey in the English Channel. Only four of the Channel Islands are of economic importance. Of these two, Jersey and Guernsey have both originated and given to the world distinctive breeds of cattle.

The ancestry of the Jersey cow is commonly thought to be French cattle, with the likelihood that the Isle of Jersey was once a part of the French mainland.

Recognizing the importance of keeping the stock pure, it has long been an actual crime for any cattle imported to the island not to be slaughtered within 24 hours. Before the 18th Century Jersey cattle were being exported into England. Since 1850 large numbers have been brought into this country where they have established high records in the richness of the butterfat of their milk.

The Jersey cows are of solid fawn color, of varying dark shades, lighter around the eyes, along the spine, and on the inner side of the legs, finally terminating in almost white on the legs. The head of the young Jersey has often been called deer-like in its graceful form.

The American Jersey Cattle Club is the organization which promotes the standards of this breed.

* * * * *

A Creature of Habit

A herd of cows may look alike to a casual observer, but any one who has the care of them knows that each has an individuality, varying in disposition and habit.

Many habits of the wild have survived the centuries of domestication, while other habits resulting from the changed environment have replaced those left behind. Habit has to a great extent replaced instinct, dulled by little need for use. Instead of living by the herd strength and competitive ability to secure a food supply, today these once important points are superfluous. Every burden of food, of shelter, of making her own way through life has been lifted from the shoulders of the cow in exchange for the sole requirement that she produce milk; and more milk.

For the average dairy cow, herd life moves serenely, consisting of little more than a leisurely walk to pasture, or the few minutes in the day when the stall door is opened, and the herd hurries into the barn where each cow at meal time seeks out her own stall for the waiting food.

Here, disposition asserts itself. One cow will seek her own stall, while the next cow may be equally determined to rush into a stall where she does not belong, or to attempt to crowd in beside some other occupant. "Gentle" is an adjective often applied to the members of a dairy herd.

The scene often pictured in art and verse is of the cow going to pasture. Cows usually feed in rather compact groups, with an occasional wanderer. In summer when the pasture grass is lush and tender, life for the cow would seem to be one blissful swing of the pendulum between eating and resting.

The cow in preparing to lie down goes about it in the reverse fashion from the horse. The cow always drops down on her front knees first, then lowers her hind quarter, and, like a shift from high to low gear, completes the act by lowering the front portion of her body to the ground. Calves, and rather rarely cows, stretch themselves prone on the ground, head flung flat and legs stretched out straight.

The instinct which causes the members of a herd to all desire to do the same thing at the same time has been described as "a sort of mass psychology." When one cow starts to amble towards the pasture gate which leads toward the barn, the entire group will usually follow. This might be either herd instinct or the common need for feeding, drink or rest.

If the dairy cow has become largely a creature of habit she has, on the other hand, become one of the most highly specialized of the domestic animals on the farm.

* * * * *

Food for the Cow

"All dairy herd improvement in the past may be traced to three things:—selection, breeding and feeding." (Pirtle.) These three factors apply with equal force to all plant and animal life. It is the third factor, i.e. that of feeding, upon which depends whether or not the owner of a high milk-producing cow is to avail himself of the benefits of the past two centuries of improvement. Unless proper care of the cow is constantly maintained, the dairy type of cow would quickly revert again in a few generations to a cow of the wild, producing only enough milk to feed her calf.

The feeding of the dairy cow has therefore become a science. So important and so direct is the relationship between the maximum well-being of the herd, and the quantity of milk produced that the major scheme of activity for the entire dairy farm revolves around the feeding program. (See Section 5, "The Dairy Farm.")

The cow has been compared to a factory which must be supplied with energy to operate its machinery before there can be output of products (Armstrong). The amount of food which is needed to merely maintain the body processes of a farm animal is called a maintenance ration and might be roughly compared to the "minimum diet" for the human. Between 40 and 60% of the food consumed by the cow must go towards maintenance. "A balanced ration" is food in the proper proportion and amount to nourish a cow for 24 hours.

The cow as well as other animals shows nutrition needs strikingly similar to those of the human body: (1) fuel to maintain normal body temperature; (2) energy to operate the various organs; (3) protein for repairing the daily losses in nitrogeneous tissues; (4) minerals to replace continous loss of these materials; and (5) vitamins for supplementing certain other needs. In addition, all animals including the cow must have air, water, exercise and sunlight. (Henry and Morrison.)

* * * * *

Importance of Calcium

Great stress is now placed upon the importance of minerals in the feeding ration. Ninety percent of the skeleton of the cow is composed of calcium. The skeleton holds the reserve supply of the calcium and phosphorus in the body. A cow which does not receive adequate minerals in her foods must draw upon that reserve supply. This results in brittle, easily broken bones. A rapidly growing calf whose food is lacking in calcium fails to grow into a cow of normal size.

The legumes, such as clover and alfalfa which may be fed either green or as hay, are a rich source of protein.

Minerals, of which the leguminous plants also have a high content, are especially important in the ration of the dairy cow. There are four sources of the ration of the dairy cow, used in various combinations:—(1) pasture; (2) hay; (3) silage; (4) grain or other mixed feed.

Pasture grass or other green forage is of great value in milk production. In fact, conditions for abundant pasture are one of the prerequisites to a successful dairying section. Dairy farmers are being urged to let pasturage play an increased part in the feeding program, as it is a cheaper food than some of the other sources. However, since the green grasses are both bulky, and contain a high proportion of water, pasturage must be supplemented with a proportion of other kinds of feed. Grasses and clovers are the principally used plants for pasture. (See Section 2 "The Plant."

Hay is an all-the-year-around feed. The legumes, such as alfalfa, the clovers and soybeans, are considered of the greatest value for hay as they serve a two-fold purpose. First, they are a source of high food value, and in the case of alfalfa, the hay may be used to some extent in place of grains in feeding. Second, they have a beneficial effect in enriching the soil in which they grow, and are therefore termed excellent soiling crops. Hay is usually used to supplement either pasturage or silage.

Silage is a term applied to feeds stored while green in buildings called silos, erected for the purpose. Corn is generally used for this purpose. Silage can be stored for use throughout the year, its chief value lying in the fact that it is thereby possible to provide the cow with a green feed in seasons when there is no pasturage. It also provides economical source of food, very palatable, but lower in proteins and minerals than the leguminous hay.

Beginning about 1810 much scientific study has been devoted to feeding standards. The cow testing associations (mentioned elsewhere) have enabled the dairy farmer to check his feeding practice closely in relation to the quantity of milk produced by individual members of the herd.

* * * * *

How Milk is Made

Milk is manufactured by the cow from the food she eats by a process scarcely less marvelous than that by which the plant transforms inorganic matter into organic (see Section 2, "The Growing Plant"). In both processes, scientists are still baffled in a full understanding of all the steps which take place.

In the cow, the transformation of the plant into milk may be roughly divided into two phases: (1) digestion; (2) secretion.

Before actual digestion takes place the coarse materials after being swallowed are softened and fermented in the paunch. In common with other cud-chewing animals it is possible for the cow to recall from the paunch food she has previously swallowed. This permits food being eaten when accessible and later rendered into smaller particles by leisurely chewing.

1—*Digestion.* The complicated process of digestion begins in the first of the cow's four stomachs. Most of the food eaten by the cow is in the form of carbohydrates, proteins and fats, which cannot be utilized by the body of the animal until broken into simpler forms. Through the action of the digestive juices present, the starch is converted into either glucose or simple

glucose-like sugars. The minerals in the material are dissolved in varying degrees by the acid of one of the juices. Finally, in the fourth stomach still more vigorous digestion takes place. This is made possible by the addition of a number of digestive juices which bring about important chemical changes in the food materials.

These materials are passed into the blood stream ready to later be reassembled in the form of milk. The richly laden blood stream flows through the arteries and capillaries to all parts of the body.

2—*Secretion.* It is in the process of secretion that an insight can be gained into the fundamental reason for the unique position which milk occupies among other foods used by the human. Digestion was seen to be chiefly a process of breaking down and transformation. Secretion is a process of assembling. Through secretion, the nutritional elements resulting from the digestive process of breaking down and transformation are gathered together in a proportion more nearly perfect than in any other food available for humans. Secretion takes place in *the udder* of the cow. The nutrients in the richly laden blood are carried through the capillaries to the alveoli, small sac-like bodies in the udder.

Nature demands of the cow that she produce a perfectly compounded product. If her food be lacking in the necessary raw materials she must draw upon her own body needs, draining even minerals from the bones in her own framework.

After secretion in the alveoli, the newly assembled product, milk, proceeds into milk ducts, the largest of which opens into the milk cistern or small cavity located above each of the four teats of the cow's udder, where it is released by "milking." (See Section 4, "The Dairy Farm.")

Milk differs in composition from the materials out of which it was compounded. Its proteins, sugar, and fat are either different from or not found elsewhere in the body of the cow. It has a high content of the minerals, calcium and phosphate. The two minerals are of great importance in the growth of the plant, (see Section 1, "The Soil" and 2, "The Growing Plant") the cow, and for the human (see Section 6, "Milk, the Food").

* * * * *

Note

Acknowledgment is made for the reading of this reference material to Mr. Adam Leland Beam, Professor of Dairy Production, Pennsylvania State College.

BIBLIOGRAPHY FOR FURTHER READING

(Rather than refer you to a bewildering list of references, only a few books are listed below, each of which is selected for a particular phase of the subject. Titles marked with an asterisk may be consulted in the Dairy Council library. If you cannot have access to any of the suggested volumes, your own library encyclopedia will prove helpful.)

*"The Cow"—Jared Van Wagenen, Jr.

The Macmillan Co., New York—$1.50

*"Cattle of the World"—Alvin Howard Sanders

National Geographic Society, Washington, D. C.

*"History of Dairying"—T. B. Pirtle

C. N. Caspar Co., Milwaukee—1926—$7.50
(For reference in history of dairy breeds, etc.)

The Cow

Down through the long long years the cow has followed man as his best friend.

There are no old and faded pictures to show us how she once looked. Only the bones of her very ancient ancestors, patiently put together by skilled scientists show us how she looked in that far away day.

There were almost as many different kinds of cows as there were people. Some of them from great thundering herds in the vast forests of Europe; others from the giant Gaurs of Asia.

The peoples, shifted about from one land to another and mixed with other peoples. The cattle became mixed too until it was impossible to know whether the red cows, tan cows, black cows, white cows, long horned cows or short horned cows were European or Asiatic in origin. They ranged from huge cattle seven feet high down to little creatures only three feet high.

Perhaps the oldest record we have today is from a ruin in Turkistan that dates back to 8000 B.C.

Scattered through old folk tales, ancient carvings and paintings on cave walls we see everywhere the cow's undisputed position as "Man's best friend."

Early man was so dependent on this friend for health that she became a part of his religion. The moon was a cow with golden horns that came over the rim of the world each month to give him new faith and courage. The great blue pastures of the heavens were full of great white cloud cattle. Man felt secure when he looked at them.

Tarus is one of the well-known group of stars in the sky at night. And Tarus, as it happens, is the family name of all our cows today. Many old families of Europe have a prefix to their names. There is the Dutch "Van", as in Van Nostrand, or the German "Von" as in Von Hindenburg. Sometimes we give these people a nickname and just call them Van. So for ages now, they have nick-named the cow, Boss, but her full name is Bos Tarus.

Bos Tarus has a first cousin who lives in India and she has the family name of Bos Indicus. Our American cows are mostly European like ourselves, and belong to the Bos Tarus family.

About the oldest type of European cow still living today, in anything like her original form, is the great white cow of England. Just as we have kept some

of our once common buffalo in Zoos so Chillingham Park has a herd of these grand old white cows. The famous Landseer painted a picture of them which you may have seen. This cow is one of the many ancestors of those we have in America today.

In the old days man took his cattle as he found them. Some were big and gave a fair quantity of milk; others were tiny and did not give much milk. There were all sizes from the shaggy little Highland cow to the huge cattle in the vast forests.

But as time went on, man wanted to keep the best qualities from different cows that he liked. The sturdy little Highland cow lived through cold winters with less food than the big cow that gave more milk. Milk was the most important food in any part of the world. Man needed strong cows and he wanted more milk. He learned to mix different types.

One of the ancestors to our modern cow was the little Celtic short horn. She was tiny, deerlike and graceful. The Jerseys and Guernseys from the Channel Islands look much like her for she was their very great great grand-mother.

The Scotchman has developed the Ayrshire cow. She has three well known ancestors. There is the sturdy Scotch Highland cow. The English cow, great wild white cow which became mixed with Caesar's Roman cows, and a descendant of the Celtic short horn.

The black and white Holsteins still look something like their ancestors, the Urs or Aurocks of the great forests in Europe.

Just as our nation is made up of almost every nationality in the world, so the cow population in the United States, which numbers 26,000,000 dairy cows not counting the beef cattle, is also a very mixed one. There are about twenty different varieties.

A dairy farmer in America today chooses one kind that he happens to like from the types best developed for dairying. The four breeds with the largest number of dairy cows in America today are Holsteins, Jerseys, Ayrshires and Guernseys.

Though the Texas Long horns are not dairy cows, their historical background is interesting. They descended from the Spanish cattle brought from the West Indies in 1521 and were remains of Columbus' boatload which he took there in 1493. They are known as range cattle and are used for beef. Range cattle need to be very strong. Lately they have been crossed with the Bos Indicus, cows of India. The Americans have made up a new name for them—Brahmans. In their native lands they are called Zebus. These humped-back cows are sacred to the people of India. They can stand more heat and drought than the original Spanish cows and so their introduction has been valuable on the plains where the sun is hot and water scarce.

The first cows that ever came to the New England shores were Scandinavian. But as Thorfinn Karlsefni took them back with him to Iceland they never became part of our American cattle.

The first cows from England came to Plymouth in 1624. Probably they were red Devon cows. The New Amsterdam cows were Dutch. The Swedes brought their own cows to Delaware.

In pioneer days a cow needed to do double duty and help to plough the fields for her own food and her masters. Today, the dairy cow has only one job—to give milk.

For years and years the dairy farmer has worked to select the cows that give the most milk. Cows eat great quantities of plant food which is made into milk. The cow is well equipped for this work and has a good digestive system with not one, but four stomachs.

You may be surprised to learn that the cow needs the same things to eat that we do. But not in the same form.

The cow has done a great deal for man and now man is learning to do a great deal for the cow. There are men who are famous for planning meals for cows.

First of all the cow needs a great deal of water. She drinks from four to six gallons a day.

The cow likes a salad every day! In the summer she gets her calcium and other minerals by spending most of the day mixing her own grasses in the big pasture bowl. In winter days her green food is about forty pounds of "silo salad", called ensilage, served to her by the farmer.

The cow of course does not eat oatmeal or bread. But sometimes she likes a bran mash. Instead of shredded wheat she eats hay seasoned with grain. For every gallon of milk she makes she will eat from five to ten pounds of hay and a pound of grain.

A cow eats her meat and eggs in the form of alfalfa and clover. The alfalfa and clover factories have some very special machinery. It can take air apart and collect a gas called nitrogen. This nitrogen is sent down to little transfer stations under ground. If you have ridden on a subway you will understand. There are platforms or stations where people change cars. On the roots of the alfalfa and clover plants are little growths like transfer stations where some of the nitrogen changes cars and goes into the soil which helps other plants.

Clover and alfalfa also store some of this nitrogen. When the cow eats the clover she gets the nitrogen that she needs. She puts some of it into her milk. Milk is one of our best forms of nitrogen just as it is for calcium.

All day long the cow chews and chews. In her four stomachs she can turn great quantities of rough plant material into one of the highest forms of human food.

Milk is the only thing that Nature manufactures that is planned just as food.

The plant manufactures food from the materials in the air and in the soil. Neither animals nor people could use these raw materials.

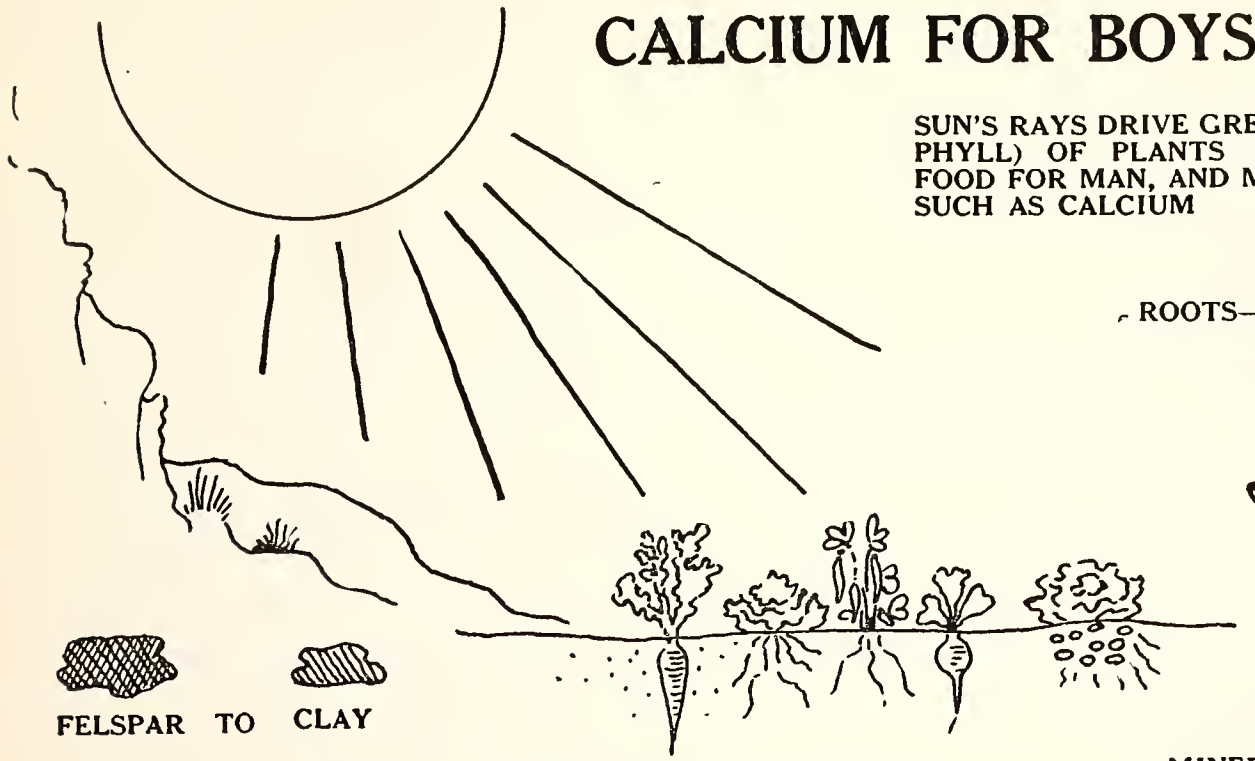
Man can eat some of his food directly from plants as fruits and vegetables. But when the cow eats coarse grasses and corn stalks she turns the plant minerals into a better form, milk.

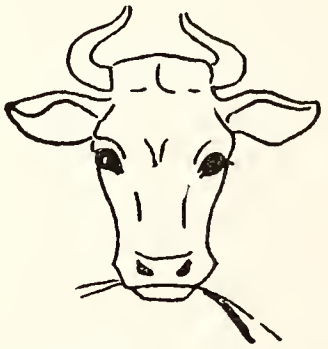
So today the cow is still man's best friend. The more we learn through science about milk, the more we appreciate the cow.

CALCIUM FOR BOYS AND GIRLS

SUN'S RAYS DRIVE GREEN MACHINERY (CHLOROPHYLL) OF PLANTS MANUFACTURE ENERGY FOOD FOR MAN, AND MINE VALUABLE MINERALS SUCH AS CALCIUM

PLANT FOODS
ROOTS—STEMS—LEAVES—FLOWERS—FRUIT AND SEEDS





MINERALS DIRECT FROM PLANTS AS COW'S FOOD

FELSPAR TO CLAY

QUARTZ TO SAND

MICA TO CLAY

LICHENS START HUMUS

HOW PLANTS, ANIMALS AND POEPLE LIVE TOGETHER

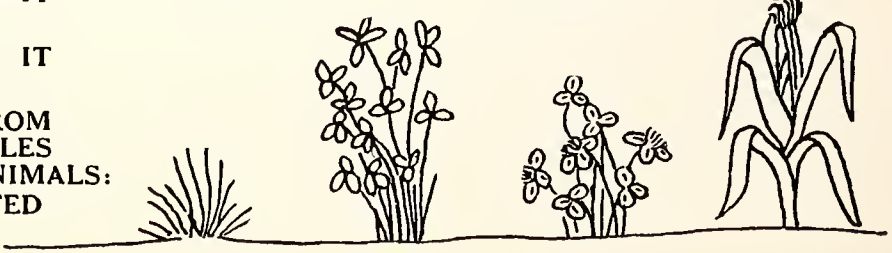
MAN CANNOT GET HIS ENERGY DIRECTLY FROM THE SUN

1—THE PLANT TAKES IT FROM THE SUN

2—THE ANIMALS TAKE IT FROM THE PLANTS

3—MAN TAKES IT FROM PLANTS: AS VEGETABLES AND FRUITS. FROM ANIMALS: AS MILK, BEST FITTED FOR MAN'S NEEDS

GRASS CLOVER CORN



THE KIND OF FOOD MAKES A DIFFERENCE

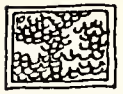
QUEEN BEE

ROYAL JELLY

WORKER BEE

PLAIN HONEY

GROWING HUMANS USE MILK CALCIUM TWICE AS EFFICIENTLY AS VEGETABLE CALCIUM



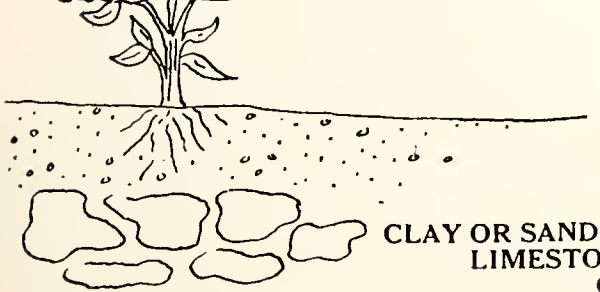
NECTAR AND POLLEN
(FOR ENERGY) (FOR NITROGEN)

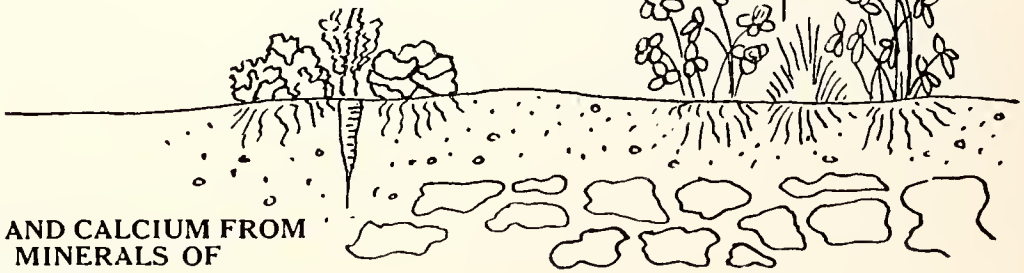
ROYAL CALCIUM FOOD

VEGETABLES

CLOVER
ALFALFA

FROM
FLOWERS





CLAY OR SANDY LOAM AND CALCIUM FROM
LIMESTONE AND MINERALS OF
OTHER ROCKS

A PREHISTORIC ANCESTOR OF THE DAIRY COW

A drawing of the wild cattle of Europe, found on the walls of a cave in Italy. This drawing, made thousands of years ago, is one of our earliest pictured records of the existence of wild cattle.

U. OF PA. MUSEUM

FROM A BABYLONIAN TEMPLE

A copper figure from a Babylonian Temple, made in 3,000 B. C. Even at this early time man had begun to domesticate cattle.

U. S. D. A.

THE OLDEST KNOWN TYPE

The wild members of the cattle family have remained almost unchanged in appearance through the centuries. On the other hand, the domestic cow has undergone marked development for dairy purposes.

PA. DEPT. OF AG.

OXEN AS BEASTS OF BURDEN

For many years domestic cattle served an all-round purpose on the farm while the modern types of dairy cows were being developed for the sole function of the production of milk.

S III—2
D. C.

OFF FOR A GOOD START

Modern knowledge of selection and breeding has gradually developed definite types of dairy cows. Each generation is reared for high milk production and true type such as shown above.

IMPORTANCE OF RIGHT FOOD

Calves, like children, must be fed a balanced diet containing adequate minerals for proper growth. The lack of calcium and other necessary minerals prevents normal growth and health.

ES III—3
. D. C.

PENNSYLVANIA STATE COLLEGE

CALCIUM MAKES A DIFFERENCE

These two calves are the same age. One calf has not received adequate calcium through its food, while the other has secured a sufficient amount. Calcium is necessary for the growth of the plant, the animal and the human.

A YEAR'S FOOD SUPPLY

The foods pictured above contain the necessary calcium and other minerals for a year's food supply for the average cow. These minerals which have been transformed in the plant leaf are reassembled in milk, which is the chief source of our own calcium supply.

R 5 III—4
P. D. C.

THE AYRSHIRE FROM SCOTLAND

The Ayrshire breed of dairy cow, developed by farmers of Ayr in southwestern Scotland, is now found in many parts of the world, and reached America by way of Canada over a hundred years ago.

THE GUERNSEY FROM THE ENGLISH CHANNEL

The Guernsey is a cross between the large red cattle of Normandy and the small yellow cattle of Brittany, made by the inhabitants of French descent on the little isle of Guernsey in the English Channel.

S III—5
D. C.

A HOLSTEIN-FRIESIAN OF DUTCH ORIGIN

The Holstein-Friesian breed of dairy cattle was brought to this country with the arrival of the Dutch settlers, who were among the earliest cattle breeders.

THE JERSEY FROM THE ENGLISH CHANNEL

The Jersey, like the Guernsey, was developed by the people of a little island in the English Channel, from which the name of the breed has been taken. Before the 18th Century, Jersey cattle were being imported into England, and since 1850 have been brought in large numbers into this country.

S 111—6
D. C.

The STORY of MILK

4. The DAIRY FARM

637.1
P53s

Contents: Section IV

No. 1. Forward to the teacher.
2. Condensed teachers reference material.
3. A Story to read.
4. We never outgrow the need for milk. (Diagram)
5. How calcium gets to man. (Diagram)
Series IV-1 to IV-6 Photos describing texts.

Foreword to the Teacher

We think of the source of milk vaguely as being "the farm" or "the cow." But beyond the cow with her definite food needs is the plant she eats. Beyond the plant with its equally definite food needs lies the soil—the source of all food.

In the soil are calcium and the other minerals necessary for our well being. But neither we nor the animals can utilize these minerals as they exist in the soil.

The necessary minerals of our own food supply are elaborated for us in a series of marvellous steps. Out of the soil which has been built up through countless millions of years, the plant manufactures from inorganic rock particles, organic food for the cow. The cow, in a second marvellous process, converts these elements into their highest form—milk.

This is the story of milk, then, through its successive phases. The subject is full of unexplored possibilities. The material is presented with as much flexibility as possible in order that the teacher may organize it to suit the needs of the individual student group.

The material is assembled under the following topics: 1—Rocks and Soil; 2—The Growing Plant; 3—The Cow; 4—The Dairy Farm; 5—Transportation and Distribution; 6—Milk, the Food. Each topic is presented in a separate folder.

PUBLISHED BY THE DAIRY COUNCIL

The Dairy Farm

"A man must choose a farm not only as a place where cows may be maintained and milk advantageously marketed, but also as a place where he may help rear a worthy agricultural civilization and found an enduring and contented family life."
VAN WAGENEN, JR.

Location of the Dairy Farm

The farmer in selecting a location for a dairy farm has a number of important points to consider.

1—Type and condition of soil in regard to its ability to grow the kind of crops needed to supply food for the dairy herd.

2—Physical aspects, such as possible water supply, proportion of land unfit for cultivation, slope of farm (whether northern or southern) and condition of roads.

3—Source of adequate water supply for home and barn.

4—Distance and possible transportation to marketing point.

5—Various human factors such as desirable neighbors and neighborhood, nearness to a school, etc.

Many farmers settled on land a hundred years ago could find a market only for such farm produce as would not suffer injury from a long period of transit enroute to a market. Within more recent years they have found themselves able to produce even perishable produce because of improved highways and the use of trucks or trains. With the growing population in cities and the increasing volume of milk needed, a large number of farms now specialize in the production of milk.

General Plan of the Dairy Farm

Aside from the area occupied by the farm home, garden, orchard, barn and other farm buildings the major portion of the acreage of the dairy farm revolves around some form of plan for raising crops which will furnish as nearly as possible the complete food supply for the dairy herd in pasturage, hay and silage.

No two farms carry out a farming plan identical in every respect, but assuming a typical dairy farm, its use of acreage might be something like the following. Permanent pasturage—fifty acres; corn—ten acres; hay, legumes—thirty acres; oats—ten acres; and a varying amount for wheat or grain other than oats.

The fields used for the different crops are varied in a careful plan of rotation. Varying from a three to seven year period, the crop grown on any particular field is changed at least once. This rotation plan is considered good farm practice for maintaining the fertility of the soil. (See Section 1.)

A Farm Day

The day begins early on the farm, usually around four or five o'clock. Every member of the family has a share in the work to be done.

The entire dairy herd is to be milked before breakfast. It takes a good milker about six minutes to milk one cow. But before milking the cows are brushed and cleaned.

As a milk pail becomes filled, it is immediately carried into the milk house. (See paragraph "The Milk House.") After milking, if the day is not rainy, the cows may be turned out into the barnyard or into pasture for several hours.

The farm family do not linger over their breakfast meal for the day's work has only just begun. If there are children, it is sometimes possible to combine in a single trip their being taken to school and the delivery of the cans of cooled milk to a highway to be collected by truck or to a country milk receiving station.

In spring, summer or autumn there are large quantities of feed to be provided for the dairy herd. The crops which furnish this food supply necessitate an annual cycle of plowing, planting, cultivating and harvesting. During the growing season, these tasks crowd fast upon each other. A rainy week may delay field operations at an important point, for wet soil cannot be plowed or cultivated. This lost time must be regained if possible by extra work as soon as fair weather permits.

In winter, when there can be no field work, necessary repairs must be made of building interiors, equipment and odd repairs such as the mending of fences, etc.

Regardless of the seasons, afternoon brings a second milking time. In fact, a few highly specialized herds are milked three, and sometimes four times a day, but this is not common. The second milking repeats the routine of the morning with cleanliness of barn, cows and utensils. Again the milk is immediately removed to the milk house, strained, cooled and kept chilled until it is delivered to the receiving station or to the highway platform for collection the next morning

Throughout the day there are the innumerable and never quite completed round of tasks attendant upon the absolute cleanliness of the milk house; sterilizing all utensils which come into contact with the milk; care of the vegetable garden and the fruit orchard for family use, and with an extra supply to be preserved for canning for winter use. And feeding of the small livestock such as a few sheep or hogs and poultry such as chickens and occasionally turkeys.

On the farm the day never seems long enough for the things which need to be done before night arrives. One does not wonder that the farm family is seldom troubled with sleeplessness. Nor does one wonder that about nine-thirty the lights in the farm homes usually begin to be put out, one by one.

There is hard work and plenty of it for every one on the dairy farm. But it is a good life And because it is a form of agriculture which particularly requires intelligent management and constant progress, it has attracted the finest type of our rural people.

The Dairy Barn

A government bulletin on the modern dairy barn points out that health "depends largely on observance of the ordinary laws of hygiene prescribed by physicians for human beings and applies with equal force to the care of animals. The principal requisites are the following: (1) An abundance of clean water and clean wholesome food; (2) fresh air night and day; (3) as much exposure to sunlight as possible; (4) avoidance of chilling and overheating; and (5) avoidance of crowded quarters."

As the herd of dairy cows requires greater care in feeding and housing than any other class of livestock, much attention has been given to an arrangement in the dairy barn which will meet these requirements. Most of the new barns follow these lines while old barns built a hundred years or more ago are being gradually adapted to modern requirements.

A quarter of an acre garden will supply a family of five with adequate vegetables. In the central eastern states it is possible to have fresh leafy or root vegetables out of the garden from about the 15th of May to approximately the first of October. The following kinds of vegetables may be grown in most gardens:—asparagus, snap beans, shell beans, lima beans, beets, cabbage, carrots, cauliflower, celery, chinese cabbage, sweet corn, cucumbers, eggplant, endive, horse radish, kale, kohl rabi, lettuce, muskmelons, onion, parsley, parsnip, peas, peppers, pumpkin, radish, rutabaga, salsify, spinach, squash, sweet potato, swiss chard, tomatoes, turnips, watermelons.

Gardens are often edged with a row of raspberries or blackberries.

The orchard varies according to individual preferences; peaches and apples are found on almost all farms. Plum, grape, quince and pear are also commonly grown.

Just as there is increasing attention given to a plan for growing field crops which will supply a balanced food ration to the herd, so it is being realized that carefully planned production of food for the household kitchen is important to the health of the farm family. The individual living in the country has fully as great need for milk, fruit and vegetables as does the inhabitant in the city. The only difference is that the former produces these foods on his farm, while the latter may purchase them delivered at his own doorstep.

* * * * *

Note

Acknowledgment is made for the reading of this reference material to Mr. Adam Leland Beam, Professor of Dairy Production, Pennsylvania State College.

The Silo

The silo is usually a cylindrical building from twenty to forty feet in height, and constructed of any one of a number of materials such as concrete blocks, tile, brick or wood. Its use is for storing green forage to be fed to cattle throughout the year, and especially in those seasons when green feed would not be otherwise procurable. The green forage stored in the silo is referred to as silage or ensilage.

A French farmer, Gottart, in writing a book in 1877 described the first silo and the advantages of corn used as silage. The first silage in America was stored at Oakland Manor, Maryland by Francis Morris who put green corn forage into a pit in the ground, covering it with earth. Today the silo built for this purpose is considered an important part of the well-managed dairy farm.

The common use of silage is due to the following advantages:—(1) It supplies a palatable feed at low cost; (2) Less of the food value is lost when stored green as silage than when dry; (3) Crops may be stored as silage when weather conditions make it impossible to dry hay; (4) Less space is required to store silage than dry stover.

The principal crop used as silage is corn. Occasionally such legumes as cowpea vines are mixed with the corn, which increases the protein value of the silage.

The filling of the silo takes place during the late summer after the corn or other crop is mature, but before it has begun to dry. For corn, the stalks are cut and hauled from the field to the base of the silo where they are chopped into one-half to one inch lengths by the silage cutter. The particles are then blown through a large pipe which carries them to an opening in the top of the silo where they drop to the floor of the interior. One person usually is occupied in the interior of the silo packing the particles as they fall.

The question is often asked, "How is it possible that green feed can be stored for many months in the silo?" When the green crop is placed in the air-tight chamber of the silo, fermentation takes place. During this period much of the sugar in the green forage is broken down into organic acids. The growth of mold and decay which takes place under ordinary circumstances, is prevented by the presence of the acids which are chiefly lactic (the acid in sour milk) and acetic (the acid in vinegar).

Only a few days is required for the fermentation process to be completed. As long as the air remains excluded, no apparent change in the silage takes place. There are records of silage still of good quality after fourteen years of storage in the silo.

The Farm Homestead

The farm home is much like any other home, except that there are conditions which have heretofore made it more difficult to secure electricity and running water than in the city or suburban homes. A water system is an independent farm unit and obviously cannot be a part of a community system. The cost of electricity has kept it out of reach of the majority of rural homes. But the number of homes with electricity and running water has nevertheless over a long period of years slowly increased.

Farm homesteads of seventy-five years ago produced from necessity all of the food and clothing needed by the family. Today when machine-made goods can be cheaply purchased, no cloth is woven on the farm. But it is still profitable for the greater portion of the food supply to be home grown. This means that not only are vegetables and fruits raised for summer use, but the canning of these foods for other seasons is planned. Chickens, hogs and occasionally turkey, guineas and sheep give variety to the meat supply.

Barns of the past were built of hand-hewn timbers, with poor economy in the use of space. The space in the modern barn is planned for the best use, and concrete is utilized in such ways as to reduce labor, the hazard of fire, permit light, ventilation and cleanliness.

The average dairy barn has a capacity to house approximately twenty cows. The greater part of the floor space of the barn is given over to two parallel rows of stanchions, arranged so that the heads of the cows are either toward the barn walls or toward the center of the barn.

As sunlight is an important factor in both the health of the herd and in aiding in cleanliness, windows must be numerous. They are frequently arranged at close intervals along the wall. These windows are commonly hinged at the bottom to permit the entrance of air at the top without causing a draft on the backs of the cows.

A dairy herd requires a large supply of drinking water, one cow often drinking 100 to 200 pounds of water in a day. In many barns water is provided in each cow's stanchion by individual drinking cups in which water is released by pressure of the cow's mouth. Cows readily learn to seek water from the source of the drinking cup. Where cups are not provided, the water supply is secured from a watering-trough usually placed in the exercise yard. The disadvantage of depending solely upon a running stream for water supply is that in bad or dry weather the cows may not receive an adequate amount.

At one end of the barn often one or two separate stalls are provided for cows with young calves. There may also be a feed room for the storing of the grain feeds. The hay is stored either in a second floor hay mow or in a nearby shed.

The silo or silos are built either adjoining or near to the barn, permitting easy transfer of the silage to feeding trough.

The Milk House

The milk house, as its name implies, is built and used solely for two purposes; (1) the care of the milk and (2) the care of all milk utensils when not in use.

Where the barn building and milk house adjoin, many states require that there shall be no direct opening from the one building into the other, and prefer that there shall be a short distance between the two. On many farms a shed between the barn and milk house offers both protection to the milk house and shelter to persons going between.

The milk immediately after being milked is brought to the milk house and strained from the milk pail into sterilized cans in which it will shortly be transported to the city.

Milk is judged partly by its ability to keep sweet. One of the chief factors in its maintaining sweetness is the temperature of the milk. Warm milk will not keep sweet as long as milk which has been continuously kept at a low temperature. Therefore, as rapidly as milk reaches the milk house it must be cooled. The common method is to stand the cans in a tank of water at a temperature from 50 to 60 degrees. When the weather is warm the water in the cooling tanks must be chilled with ice or by an electrical refrigerating unit. As additional milk is poured into the can, it is stirred in order that the contents of the can may be well mixed and equally cooled.

Once a day as soon as properly cooled it is delivered to either one of two points: (1) a stand on a highway where it will be collected by truck, or (2) to a milk receiving station located at various points in the country.

After the milk has been delivered to one of these points all of the utensils used for the milk are sterilized with boiling water. It is customary likewise to thoroughly clean the entire milk house which is constructed of a material such as concrete upon which a hose of water can be readily turned.

BIBLIOGRAPHY FOR FURTHER READING

(Rather than refer you to a bewildering list of references, only a few books are listed below, each of which is selected for a particular phase of the subject. Titles marked with an asterisk may be consulted in the Dairy Council library. If you cannot have access to any of the suggested volumes, your own library encyclopedias will prove helpful.)

*"Dairy Farming"—Wilber J. Fraser

John Wiley & Sons, New York—1930—$3.50
(Prepared as a textbook for agricultural students, but useful as reference on the general subject)

*"History of Dairying"—T. B. Pirtle

C. N. Caspar Co., Milwaukee—1926—$7.50
(For reference history in dairying in the United States and other countries)

The Dairy Farm

Nature has worked for many, many years to make the good earth on which we live. But after all, Nature's ice picks, the frost axes, water drills and sun forges are slow. Too slow for this age! After Nature makes the soil it takes the plants a long time to do their work.

But a farmer who studies science makes Nature a good partner. Together they can take a farm and do in five years what would take Nature fifty years to do alone.

Farmers are always busy for their work is very important. People in the city are grateful to the farmers for growing all kinds of fruits and vegetables and for keeping cows to give them milk.

A dairy farmer who tends his cows well knows that he is helping to make all the people in the city healthier and happier. He knows that his cows are turning the pasture grasses and clover into man's most wonderful food. When he reads what the men in Science write about milk, he is proud to be Nature's partner.

If you were a dairy farmer you would first of all need some land. Some places have soil suited to one kind of farming; others offer conditions best suited to another. In New England there are many abandoned farms. These farms are not fertile. They were used a long time before people learned to put back into the soil the minerals that the crops took out.

Nature alone could make the farm all over; but it would take her about fifty years. First would be weeds, then shrubs and finally forests.

But a dairy farmer as Nature's partner can reclaim an old farm in five years.

You can find out a great deal about the land nearby or from a soil map of the county. If your state has an agricultural school you can get facts from it. The state library will tell you where to write for a report of the minerals and rocks. Perhaps some of the land is rocky. If those rocks are limestone you will have good pastures.

If there are no trees plant them at once. Trees help to keep the wind and rain from wearing away the good soil. Grassy pastures also help to anchor the soil.

A good dairy farmer is like a wise builder. He makes a plan for his farm. He needs some land for pasture, some for hay and grain, some for corn and alfalfa for his cows. A garden and an orchard give fruit and vegetables for the farmer's

family. You can not keep more cows than you can feed. Twenty cows can live well on 100 acres of land.

Where will you plant the corn? The alfalfa? The hay?

High and dry hillsides are sunny and warm. Low valley land has early frost. Most plants live best in a temperature of 60° or 70° and do not grow at all when it is only 40 degrees.

Corn needs a long hot summer.

You will be interested to get a weather map or report for your locality. These maps tell whether frosts come early or late. Water is important. The reports will give the year's rainfall. An inch of rain will mean 113 tons of water on every acre where it falls.

A good farmer must learn how to help his soil keep this water. There are three ways a soil loses its water. One of these you may know. The others may be new to you.

1—Evaporation—when water stands it disappears into the air. Arabs wear heavy clothes in the hot desert to keep the water from evaporating from their skins.

2—Percolation—water naturally runs down. It goes through the soil. This is percolation.

3—Transpiration—when we breathe it is called respiration. When plants breathe—transpiration. Plants lose water through their leaves by transpiration.

Sometimes a farmer puts a covering or mulch over his field. It acts like paraffin over jelly, and keeps the water from evaporating.

Trees and grass keep water from draining away. The trees and plants lose their leaves in winter to keep the water from being breathed away. The water turns to sap and will not be injured by freezing weather.

Ploughing, too, needs some study. Clay lands are ploughed deeper than sandy fields. There are a great many reasons why farmers plough. Sometimes fields are ploughed in the fall just to kill insects. Sometimes clover and bean crops are ploughed under to give back nitrogen to the soil. There are many things to do for the soil. You already know how important calcium is as a mineral. It does two things for the soil. It removes the acid and helps the plants to get the foods they need. Lime is a commercial form of calcium.

The dairy farmer changes the crops he plants in each field. If he plants corn in a field this year, next year he will plant some other crop in that field. He changes even the fields used for pasture.

A real dairy cow is one that specializes in making milk. Long ago farmers needed a cow that could help plough. But if a cow works she does not give so much milk. The dairy farmer wants a cow that spends her whole day making milk. Turning calcium and nitrogen and other plant materials into the best food forms for man.

Cows are valuable and important. They must have a good home. The barn should be a clean comfortable home for the cows.

Barns are really important. The size will depend on how many cows you keep. If you have 20 you can easily plan how big to make the barn. Each cow needs a clean stall 36 or 42 inches wide and $4\frac{1}{2}$ feet from her manger to the gutter. Each should have a drinking cup.

There must be room for calf pens, haymows and plenty of windows for light and air.

Why not build an attractive barn as well as a useful one? Beautiful every day things make our homes lovely and liveable.

Perhaps you can think of interesting plans for silos or corn cribs. A silo 30 feet high and 16 inches across will hold 120 tons of winter greens. How many acres of your land will you need for corn? Each acre will produce about 12 tons of silage.

Perhaps you had better plan how to divide the farm? How many acres for pastures which the government says is so important? How much for other crops to feed your cows? For corn? For hay? For oats?

Pastures come first. You will need 50 acres of hay for your land.

Ten acres in oats will give you 500 bushels. Ten acres in corn give you 120 tons of silage. You will need a silo 30 feet high and 16 feet across to hold this much. Cows eat a good deal of the silo salad we call ensilage in the winter, you know. That leaves you 30 acres for growing 45 tons of hay.

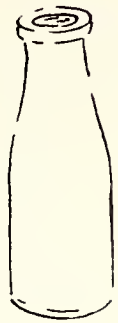
Your 20 cows are going to keep you busy. There will be a few calves and yearlings. You must have 2 or 3 horses to cultivate corn, to plough, to lime your field, and to bring in the hay.

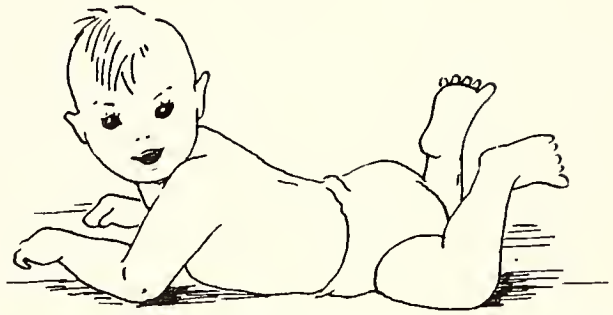
A dairy farmer spends most of his time growing food. Cows need very good food. If they are not fed well with the plants they need they sometimes eat poison weeds, milkweed, larkspur, cocklibur or arrowroot. Their own bodies will be robbed for minerals to make into milk. And the cows will give little milk. Poor food is a bad investment.

The dairy farm is a great food industry. The cows must be well fed by the plants; the plants must be well fed from the soil; and the soil must be supplied with all of its minerals and materials.

No wonder the farmer is a busy person. And such an important one!

WE NEVER OUTGROW THE NEED FOR MILK—

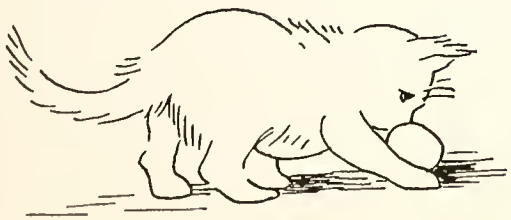




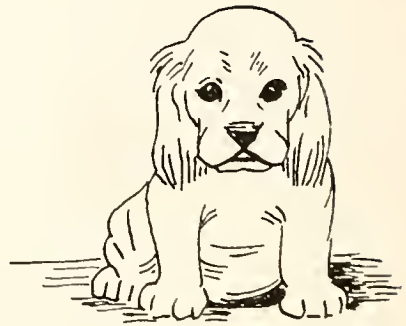
THE KITTEN GROWS FOR LESS THAN A YEAR. THEN HE IS A FULL-GROWN CAT. HE IS AN OLD MAN AT 8-10 YEARS

THE PUPPY EXPECTS TO GROW FOR TWO YEARS AND BE AN OLD MAN AT 10 OR 14 YEARS

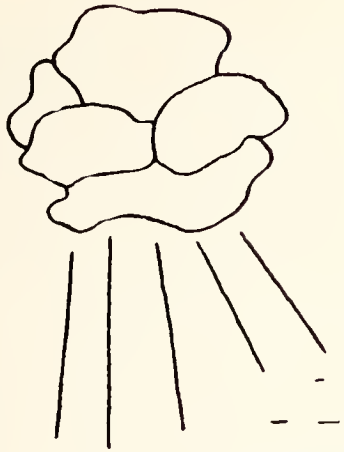
A BABY IS GROWING FOR 21 YEARS. HE NEEDS A QUART OF MILK ALL THAT TIME. HIS BABY BONES ARE VERY SOFT. HE NEEDS A GREAT DEAL OF CALCIUM TO MAKE THEM STRAIGHT AND STRONG



THE HUMAN BABY NEVER WANTS TO BE OLD. HE WILL BE ACTIVE AND HAPPY UNTIL 75 IF HE EATS PROPERLY.

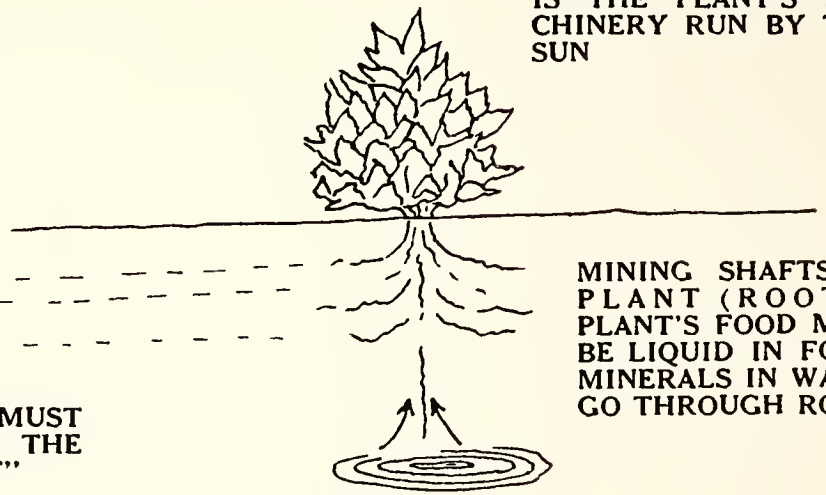


HOW CALCIUM GETS TO MAN



CALCIUM IN LIMESTONE

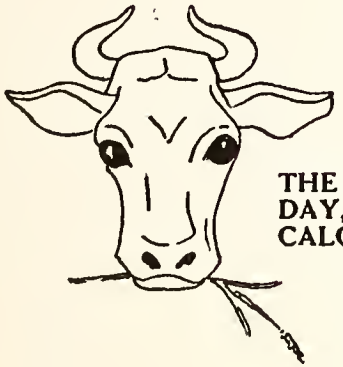
GREEN CHLOROPHYLL IS THE PLANT'S MACHINERY RUN BY THE SUN



MINING SHAFTS OF PLANT (ROOTS). PLANT'S FOOD MUST BE LIQUID IN FORM. MINERALS IN WATER GO THROUGH ROOTS

MINERALS IN THE SOIL MUST BE FINE ENOUGH FOR THE THE PLANT TO "DIGEST"

WATER



THE COW HAS FOUR STOMACHS AND WORKS ALL DAY, CHANGING GRASS CALCIUM INTO MILK CALCIUM

OUR ONLY "A" FOOD

MILK IS TWICE AS VALUABLE A FORM OF THE PRECIOUS MINERAL, CALCIUM, AS VEGETABLES.

GREEN LEAVES OF GRASS, CLOVER, ALFALFA, CORN

A TYPICAL DAIRY FARM

Modern dairy farms are planned with the same precision as any other industry. Balanced fertilization of soil, well maintained pasture, proper crop rotation, good livestock, equipment and hard work are requisites.

HARVESTING GREEN CORN

Corn is cut while it is still green to supply green food for the dairy herd throughout the winter. The plant furnishes the cow with the same minerals which are necessary for us, but which we secure from milk.

STORING CORN IN SILO

Green corn is run through an ensilage cutter, which at the same time cuts the corn into pieces about half an inch long and blows it up through a long pipe into the silo. This ensilage is then stored for use throughout the winter.

HARVESTING HAY

Part of the minerals for the dairy herd are secured from leguminous hays such as alfalfa or clover. It is cut and raked into rows. When sufficiently dried it is hauled to the barn for storage.

IES IV—2
I. D. C.

STORING HAY

Hay is here being unloaded and elevated mechanically by means of a large hay fork up to the barn loft, known as the hay mow.

INTERIOR OF DAIRY BARN

An abundance of light, adequate ventilation, clean concrete floors and mangers, dirt tight ceilings, clean white walls and individual drinking cups for each cow, are essentials in the modern dairy barn.

FEEDING A BALANCED RATION

The daily food supply for each cow is carefully assembled to assure the essential food requirements. Ensilage, mixed feeds and most hays supply the necessary calcium and other minerals. A deficiency in any of these needs is reflected in the milk production chart.

MILKING TIME

At milking time the herd is usually waiting at the barn door, each cow ready to seek her stanchion. Before milking, the cows' clipped flanks and udders are washed. Cleanliness of surroundings, attendants and utensils accompanies the process of milking.

IN THE MILK HOUSE

As each cow is milked, the milk is immediately carried to a separate building known as the milk house, where it is strained into sterilized cans and promptly cooled for shipment to the city.

FOOD FOR THE FARM FAMILY

The production of food for the farm family must not be overshadowed by the activities of securing food for the farm animals. Green vegetables, fruit and a generous supply of milk comprise the "protective foods" for health.

FRUIT FROM THE ORCHARD

The orchard and garden furnish not only fresh fruits and vegetables during the summer months, but wise planning permits a surplus which is stored or canned to furnish a winter supply of these foods.

MILK THE BASIC FOOD

Milk is our best source of calcium. This mineral is essential to the plant, the animal and the human. Also it is the mineral most likely to be deficient in our diets. A quart of milk daily for the child and at least a pint for the adult best supplies our mineral needs.

The STORY *of* MILK

5. TRANSPORTATION - DISTRIBUTION

637 1
P53s

Contents: Section V

No. 1. Forward to the teacher.
2. Condensed teachers reference material.
3. A Story to read.
4. Transportation. (Diagram).
5. What makes them go? (Diagram)
Series V-1 to V-6 Photos describing text.

Transportation and Distribution

A reader of the "Western Sun" newspaper wrote in 1830, of the first use of trains, "I see what will be the effect of it!—grave plodding citizens will be flying about like comets. All local attachments will be at an end. It will encourage flightiness of intellect. All conceptions will be exaggerated by the magnificent notions of distance. Only a hundred miles off! Tut, nonsense, I'll step across and bring your fan! And then, sir, there will be barrels of pork, cargoes of flour, caldrons of coal, and even lead and such like sober things that have always been used to slow travelling—whisking away like a sky rocket. Upon the whole, sir, it is a pestilential topsy-turvy, harum-scarum whirligig. Give me the old, solemn, straight forward Dutch canal—three miles an hour for expresses and two rod jog-trot journeys with a yoke of oxen for heavy loads. None of your hop skip and jump whimsies for me."

In Earlier Days

In earlier days before so many of our towns grew into cities, it was possible for each family to produce most or all of its own food supply. Wood-cuts of "The Green Countrie Towne" of William Penn show Independence Hall in the heart of Philadelphia to have been lined with little houses, each with a yard and a garden.

As villages and towns grew in size, there was less space for gardens or for domestic animals. Finally, there was no space left for the town dweller to produce his own food as in the past. This brought about farming as a distinct occupation. The farmer produced an additional supply of food above the needs of his own family. This he sold or exchanged in the town for manufactured articles.

Transportation was only a matter of a few miles, for the milk and vegetables could be delivered to the doorsteps by the farmers who drove to town in a cart or carriage. But with the gradual development of great cities millions of people have become dependent upon the purchase of their entire food supply. As the area of a city spread, the agricultural sections have been steadily pushed further into the country by the mounting costs of land. Consequently, although part of a city's milk supply can still be produced in the nearest agricultural sections, today much of it is transported from a distance of a hundred miles or further. Transportation has therefore become an increasingly important factor in a city's daily milk supply.

Among the great variety of foodstuffs which are to be found at every season of the year in large cities, milk is by far the most perishable of all the foods. For this reason it was long considered impossible for milk to be transported any distance. A hundred years ago when there were no automobiles to provide speedy transportation, the idea of transportation of milk by the then few railroad trains was a fantastical idea.

The first attempt at shipment of milk by train was into Boston over the Boston and Worcester Railroad in 1839. Apparently the venture was unsuccessful, for there are no records to show that the experiment was made a practice until 1841 when the Orange County farmers in New York state were persuaded to try the shipment of milk into New York city. The milk was shipped in the pyramid churns of that time. These churns were wasteful of space, and there was no provision for keeping the milk cool while in transit to the city during summer months. Consequently the frequent failure of milk to retain its sweetness was continually discouraging to the pioneers in milk transportation.

The story of the evolution of modern transportation and its triumphs is strikingly written in the changes which invention and science have brought about in the method of milk transportation. It has been revolutionized by the development of the powerful train engine, motivated by steam or electricity and capable of great speed over smooth road beds and steel rails; by the coming of the automobile and the improved highways, and last but not least, by the more recent perfecting of the thermos-like refrigerated tank railroad car or truck.

When Milk Leaves the Farm

Every phase of the business of producing and marketing milk, whether it be feeding and milking the cows or transporting the milk to the consumer must be conducted with the utmost regularity three hundred and sixty-five days a year, regardless of holidays and weather conditions.

Those alike who produce milk or transport or distribute it may appropriately borrow the slogan "The Show Must Go On." And go on it does, for regardless of conditions which may delay or stop other traffic, the milk truck or train must be pushed on through to its destination. It is imperative that a city's population receive a regular supply of milk.

Hence it is that in the worst of winter weather, farmers band together to aid each other in "getting the milk out" to the highway where the milk cans can be collected by trucks. In snow storms milk routes are the first roads to be cleared by state highway departments. Some of the milk trucks operate their own snow plow. Special trains and special crews are assigned exclusively to the milk traffic whose problems are supervised by special milk departments. No matter how low the thermometer, or how hot the summer's day, with unfailing regularity the white stream pours from thousands of farms into each and every city.

When milk leaves the farm, if the farm be located at a distance greater than ten or twenty miles from the city, there are two possible methods for transportation to the city—by train or by automobile truck, depending upon local conditions.

The Country Receiving Station

Scattered throughout any rural territory supplying a city with milk there are a number of so-called country receiving stations to which milk is delivered by the individual dairy farmer, or by a truckman who is employed for the purpose of collecting the milk. Although a portion of the milk supply is directly delivered to the city by the producer or group of producers, the greater portion of it is delivered to a country receiving station.

At the country receiving station, a record is made of the milk received from each farmer whose payment for the milk is usually based on three points: 1—the quantity; 2—the butterfat; 3—the quality.

1—The quantity, in many milk markets, is measured in terms of weight. For example, the market price may be quoted per hundred pounds. A hundred pounds is equivalent to forty-six and one-half quarts. Milk is commonly brought to the receiving station in eighty-five pound cans.

2—In most milk markets a scale of prices is offered according to the amount of butterfat the milk contains. For example, a can of milk testing 4.5 percent butterfat would have a higher value than milk testing 3.5 percent.

3—In some instances the farmer is offered a premium or bonus for milk which meets an especially high standard of quality. Milk failing to meet the minimum standard is rejected at the receiving station, and returned to the farmer.

Having passed all requirements, the milk is transferred to either a tank truck or tank railroad car, thence to be transported to the city.

As promptly as possible the milk should be removed from the doorstep where it is exposed to sun or freezing. After the bottles are thoroughly wiped with a damp cloth they should be placed unopened in the coldest part of the refrigerator, as near as possible to the freezing unit. After the bottle has once been opened, it should always be returned to the refrigerator with an inverted tumbler placed over the top. These important points in care should be observed as habit by each member of the family.

For reference material on modern nutrition knowledge on the subject of milk, consult "Milk, the Food"—Section 6 of this series in "The Story of Milk."

Note

Acknowledgment is made for the reading of the reference material on transportation to Mr. W. L. Buchanan, Milk Traffic Agent of the Pennsylvania Railroad

BIBLIOGRAPHY FOR FURTHER READING

(Rather than refer you to a bewildering list of references, only a few books are listed below. If you cannot have access to any of those suggested, your own library encyclopedias will prove helpful.)

"The Pageant of America"

Compiled by the Yale University Press
(Consult public or school libraries)

"Trains, Tracks and Travel"

Simon and Bordman

"The Pageant of America"

Compiled by the Yale University Press
(For adults. Consult school or public libraries)

"Trains, Tracks and Travel"—VanMetre

Simon and Bordman, New York
(For the 10-14 age level)

Consult available books for young people, for further reading on the automobile, train, electricity, modern refrigeration, etc.

The bottling of milk is accomplished entirely by machinery. Sterilized chilled bottles are fed automatically to the bottling machine which deliveres the exact amount of milk into each bottle, caps it, and passes it in review before an inspector who scrutinizes each bottle to see that it is perfectly filled and capped. The filled bottles are placed in crates, and after a final rinsing are placed in a refrigerator room, ready to be transferred within a few hours to the milk wagon or delivery truck for the last stage of transportation to the consumer.

No milk goes out for delivery without a final laboratory test of samples of the milk. Either at the country receiving station or at the city plant a total of five tests of that milk have been made: The Babcock Test, to determine its content of butterfat; Specific Gravity Test, for other food solids; Acidity Test, upon which depends its keeping qualities; Sediment Test, an index to the sanitary conditions under which it was produced; and finally, tests to determine the Bacterial count, which is a criterion of the care used in production and handling.

Many of the large city plants maintain a fully equipped laboratory for making these tests, which are supplemented and supervised by city and state departments of health.

Modern Care and Cleanliness

Infinite care is given to every phase not only in the production of milk, but in its transportation to the consumer. This care reaches a culminating point in the city milk plant. One-third of the operative time in the plant is taken up with actual cleaning operations. Every piece of milk equipment in the plant is daily taken apart and sterilized. Before being used the following day it receives a second sterilization. The bottle-washing machine performs its task, involving seven distinct processes, at the rate of 124 bottles a minute. Each bottle is rinsed in lukewarm water, soaked, scrubbed inside and out, sterilized, and then cooled. The walls and floors of the plant are of tile or covered with water-proof paint. The operators wear washable white uniforms. The modern city milk plant embodies cleanliness throughout. The ceaseless throbbing of the power unit operates the mass of machinery with which the plant is filled. Not only does the power unit turn the wheels of machinery for the many mechanical processes, but it generates steam for sterilization, electricity, and the making of ice for refrigeration.

The Delivery Route, the Last Step in Transportation

Consumers seldom see the milkman who deliveres their orders of milk and dairy products. He arrives long before most of the city is stirring. The bottled milk, packed in crates holding 12 quart bottles each have left the plant in wagons or trucks around 3 A.M. In the densely populated residential parts of the city where numerous short stops are made, the horse and wagon is still frequently used. Some milk wagons are now equipped with rubber tires while the horse is also rubber shod for the benefit of light sleepers! A horse quickly learns the delivery route and makes the proper stops with few instructions from the driver. A milkman delivers an average of from 250 to 450 bottles of milk. He is responsible for securing payment for the milk he deliveres, and for securing the return of milk bottles. Careless customers who break or fail to properly return the bottles, which average 20 to 30 trips, are contributing to an unnecessary expense of milk transportation. When the milk has been delivered to the consumer's doorstep its care thenceforward depends upon that home.

It's Up to You

When the milkman deposits the bottled milk on the doorstep of the user, his responsibility is ended. The continuing of the care which has accompanied each step of the journey from the cow to the city doorstep must now be assumed by those in the home. Any failure to maintain this care in the home is no less disastrous than would have been any negligence on the farm or in the city distributing plant.

The Great White Fleet

The tank railroad car and the tank truck, both particularly designed for the purpose of transporting milk, have marvelously combined modern knowledge of science and perfection in machinery. The first tank railroad car made its appearance in Boston in 1914. It was merely a tank mounted in one end of an ordinary freight car. A tank car definitely designed for the purpose was not made until 1921, and was first used in Chicago. It was a forerunner of the refrigerator type of car, equipped with ice bunkers and brine coils and with two 3,000 gallon tanks in each end. The brine coils have since been eliminated because sterilization of the tanks is now accomplished chemically instead of with steam as in 1921. When steam was used, it was necessary to afterwards chill the car, the brine coils being utilized for the purpose. One of the most important advantages of the tank car is its ability, because of its thermos-like construction, to maintain a low temperature without refrigeration during the entire period the milk is in transit. In an experimental test, milk has been shipped 2,500 miles, and held for eleven days in an insulated tank of this type with but slight increase in the temperature of the product being shipped.

In short distances of transportation the tank truck is usually used instead of the tank railroad car. The tank truck of today has an average capacity of between 2,000 and 3,000 gallons and, like the tank cars, is either glass or metal lined and insulated. Many of these tanks are completely covered with several inches of cork board, and over this a water-tight jacket of some metal such as aluminum.

Not only do the latest models of milk trucks carry all manner of insulation against heat and freezing—either would be injurious to the milk—but they are equipped with every possible device for safety in traffic and under difficult road conditions. These modern tank trucks are usually 6 cylinder and 6 wheeled with 120 horsepower. They carry a 4 wheel drive, with 6 wheel brakes, and driver's cab is entirely closed. Dual pneumatic tires are used on all wheels except the steering.

These great trucks are able to draw their heavy bulky loads over icy pavements when the ordinary 4 wheel trucks are unable to travel on the road. Regardless of storm or blizzard, every effort blends toward the faithful arrival of the great white fleet which daily pours a steady stream of milk into our waiting cities.

The City Plant

Transit from the farm to the city distribution plant is only one phase in the transportation of the milk to the door of the consumer. Many steps intervene.

Whether the milk has arrived at the city plant by train or truck, it is in either case immediately re-cooled and pumped into tanks usually located on the top floor of the plant. From there it flows by gravity through the various processes of pasteurization, cooling and bottling.

Pasteurization is a process, discovered by the French scientist Pasteur, which kills bacteria with heat. Although Pasteur first applied his discovery to certain bacteria found in wine, pasteurization of milk is now required by the health departments of most metropolitan markets. It consists of heating the milk to a temperature not less than 143 degrees F. and holding it at this temperature for not less than 30 minutes. Pasteurized milk has essentially the same food value as unpasteurized milk.

Many city milk plants, in connection with the pasteurization process utilize *an ingenious cooler-heater system* whereby the cold milk flowing to the pasteurizer helps to chill the hot milk flowing out of the pasteurizer. So, also the hot milk coming from the pasteurizer helps to raise the temperature of the milk on its way to the pasteurizer. This frugality saves seventy-five percent of the heat and cold units which would otherwise be required first to pasteurize the milk and then to chill it to approximately 34 degrees.

Foreword to the Teacher

We think of the source of milk vaguely as being "the farm" or "the cow." But beyond the cow with her definite food needs is the plant she eats. Beyond the plant with its equally definite food needs lies the soil—the source of all food.

In the soil are calcium and the other minerals necessary for our well being. But neither we nor the animals can utilize these minerals as they exist in the soil.

The necessary minerals of our own food supply are elaborated for us in a series of marvellous steps. Out of the soil which has been built up through countless millions of years, the plant manufactures from inorganic rock particles, organic food for the cow. The cow, in a second marvellous process, converts these elements into their highest form—milk.

This is the story of milk, then, through its successive phases. The subject is full of unexplored possibilities. The material is presented with as much flexibility as possible in order that the teacher may organize it to suit the needs of the individual student group.

The material is assembled under the following topics: 1—Rocks and Soil; 2—The Growing Plant; 3—The Cow; 4—The Dairy Farm; 5—Transportation and Distribution; 6—Milk, the Food. Each topic is presented in a separate folder.

PUBLISHED BY THE DAIRY COUNCIL

Transportation and Distribution

High up on the side of one of the White Mountains in New Hampshire is a rock that looks like a man's head. It is called the Old Man of the Mountain and was carved by Nature. People think it is very remarkable and come miles to see it.

More wonderful than Nature's Man of the Mountain is man himself. Nature made him, too, from the rocks, but it took her millions of years and required many, many steps. First the rocks were slowly changed to soil. When the soil was right, living plants grew. After the plants came amimals of all kinds and man.

The soil fed the plants, the plants fed the animals; the plants and animals worked together to feed man. And so it was that Nature slowly turned rocks into men.

But it is not so simple as it sounds. Nature still holds back many of her secrets. But she is willing to go into partnership with man. Man has a brain and can think and study. Already he has learned many very wonderful things. But it is only a little of what there is to know.

Nature's plants are living things but they stand still. Animals and men can move, swim, run and walk. It took man centuries to know how wheels could help him to go faster. Today he rides in trains and automobiles with fast turning wheels.

Maybe your ancestors were pioneers and you are like them. There are great adventures and discoveries yet to be made on the Frontiers of Science. But right now, in a simple way, shall we see how man resembles an automobile?

An automobile must have a good framework or chassis. This is made of steel—a special mixture of iron and carbon. Tall, modern buildings would never have been possible without the discovery of steel. It is much stronger than iron alone.

Man's chassis must be specially made, too, of strong minerals. His framework is made of hollow bones. The most important minerals used is calcium. Nature uses Calcium and another mineral, phosphorus, mixed in just the right amounts for this human steel. Of course she must have these materials with which to work or the bones may be soft and bend. We want a sturdy and straight framework.

Nature has even prepared these minerals already mixed and in the best forms for us. The plants mined them out of the soil. The cow remade them into milk the best form for the human chassis.

The steel parts of an automobile are riveted together with bolts. The human steel of man's chassis must also be held together.

The sun shining on our skin actually makes bolts for us. Scientists have given them the name of Vitamin D. When the sun isn't shining, we eat food that has in it Vitamin D.

To build a human chassis, experts have found that we need a quart of milk every day until we are through building or growing. If we cannot be in the sunshine we eat eggs, and butter. Many, who know about it, take cod liver oil. Those bolts are important in good building.

You can use other foods for steel but Nature's best quality is from milk.

The chassis alone is like a bare tree in the winter. How much lovelier the tree is with all its leaves in summer? Our skeletons are covered by a great mixture of materials, but it is a little like the leaves. Leaves need nitrogen and so do we. Leaves breathe and have veins through which water and sap run. We too breathe and have a circulation system. One of the important materials both the plants and humans need is nitrogen. We have to get nitrogen for our bodies from the plants. We cannot take it out of the air we breathe.

Perhaps this is why meat, eggs, milk and some vegetables are called body builders. These foods give us our nitrogen. Again milk gives us nitrogen in a very good form. Nitrogen foods are not at all simple ones. You will want to go exploring later and learn more about them. Just now we will remember that nitrogen foods are important to the covering over of our chassis.

The human chassis of bones needs the minerals, calcium and phosphorus and the body of the car must have among many other things, nitrogen.

And now—what makes the human automobile go?

That will be easy for you. You know that food makes it go. The tanks are filled at breakfast, dinner and supper. Usually three times a day. But how are you going to buy your power? Gasoline is measured by gallons. The energy of food is measured by calories. A little car does not need so many calories as a big one. The faster we go, or the harder we work the more calories we need. That is like any automobile.

But food does more than just make us go. About 500 calories will run this human car from morning until noon. But food also helps not only to build our chassis but to protect the body covering as well.

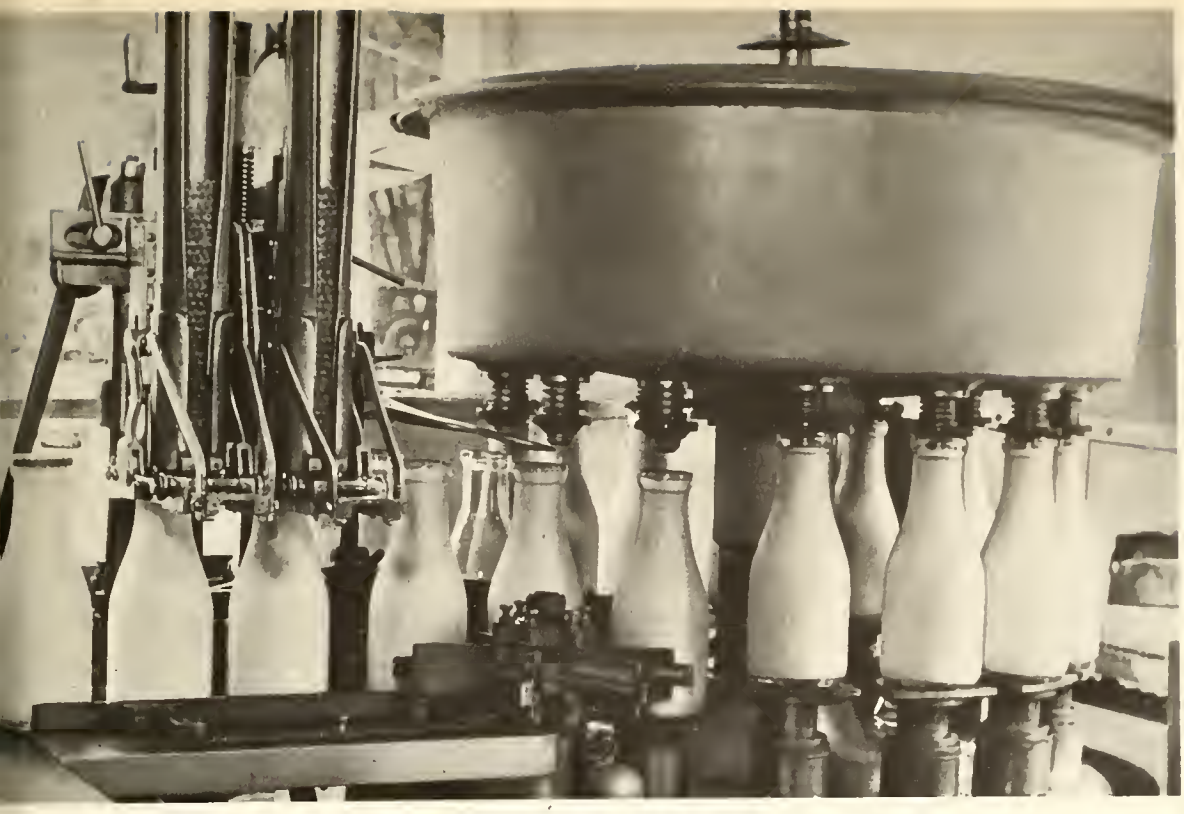
Humans need protection. We cannot drive through bad weather in an open car. We need protection from a very strong enemy—disease. Disease is like a highway man ready to pop out at us on the road if our car is out of order.

Good foods help to protect us, though not altogether. But they really do a great deal.

There are some diseases which never can attack us if we have all the things we need. Scurvy is one of these. Of course, you cannot know all of them now. Vitamins in our food do a great deal to protect us.

A food that would do the most in building and running a human car would be marked "A." Expert human engineers say our best foods are milk, vegetables, fruits, eggs and whole grain cereals. But of all these excellent foods only one is marked "A." Only milk gets an "A"! It gives us more of all the materials we need than any other food. It does not give us everything we need or enough of them, but Science still puts milk first.

We need vegetables and fruits, too. They are excellent, probably "B" foods; but milk our "A" food is the only one whose whole job is just to be a food.



BOTTLING THE MILK

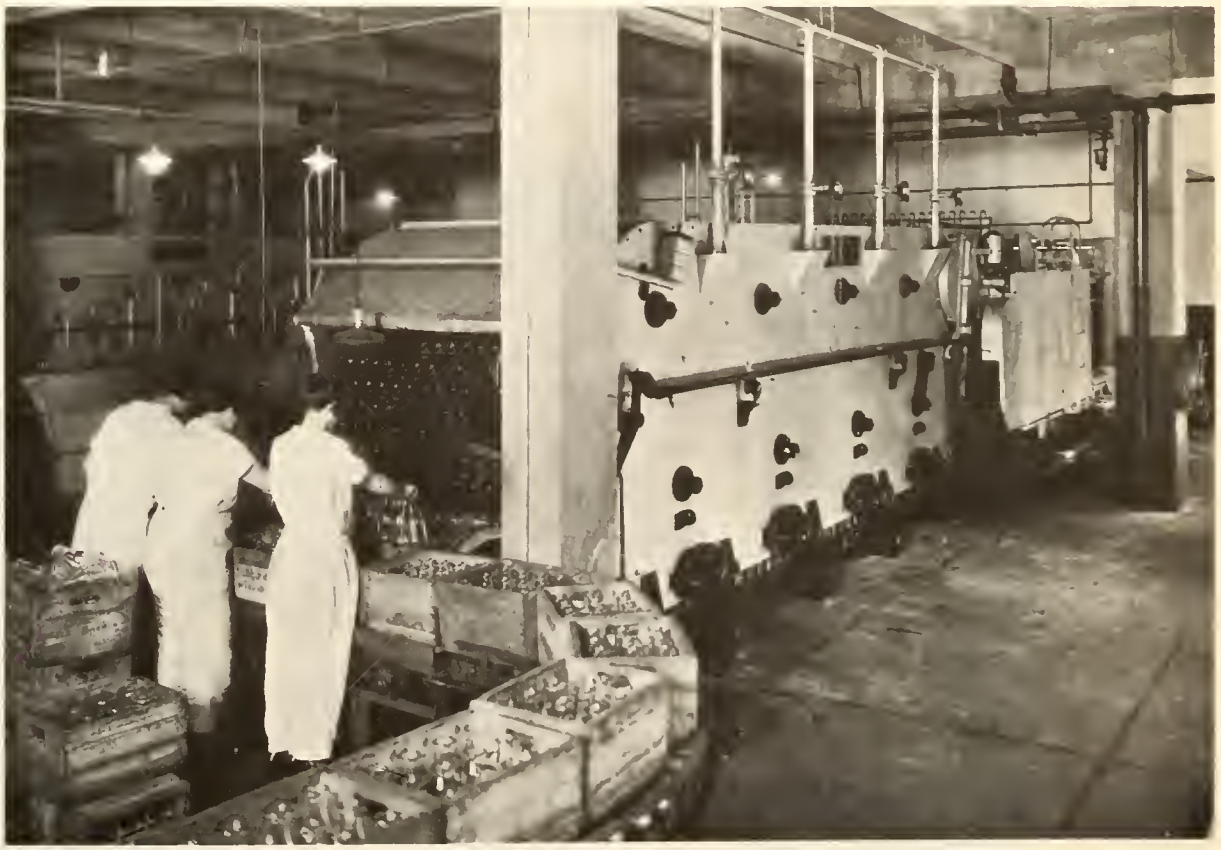
Cool sterilized bottles move in a row on a conveyor to the bottle-filler, which automatically fills and caps each one. An inspector checks each bottle as it leaves the bottling machine. The milk is then placed in a refrigerator room ready for delivery.

AT YOUR DOOR

The delivery of milk to your doorstep is the end of a long, painstaking journey. Long, in the time required by nature in preparing the minerals and other elements which make milk our most nearly perfect food, and painstaking, in the care taken to preserve its high degree of quality.

COOLING THE MILK

Immediate cooling follows pasteurization as one of the steps followed with absolute precision in the preparation of the milk for bottling.

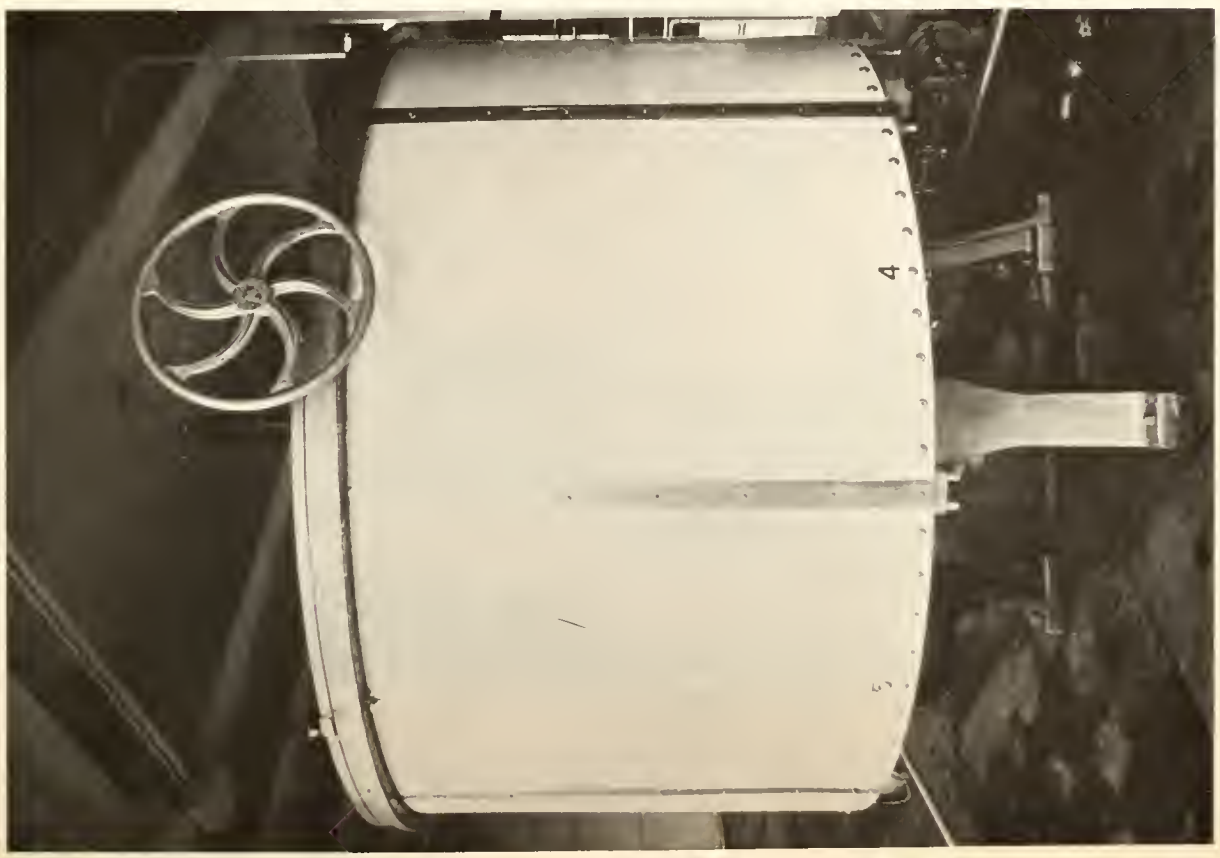


STERILIZING MILK BOTTLES

Before the bottles are ready to be filled, each bottle undergoes thorough cleansing consisting of seven steps including sterilizing with steam. Some machines thus prepare the bottles for the milk at the rate of 124 per minute.

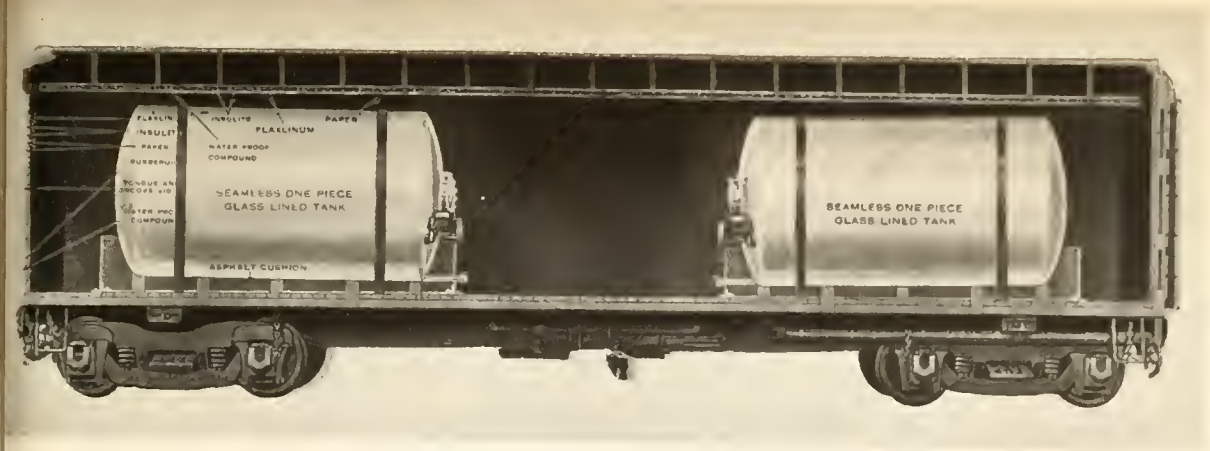
THE TEST FOR QUALITY

Before the city distributor accepts the milk, it must pass a test for quality. It is also tested for butterfat. The farmer receives a bonus for the butterfat above the minimum required in his market.



PASTEURIZATION

Pasteurization, discovered by Louis Pasteur, and now widely required by city health authorities, consists of killing bacteria by heating milk to a definite temperature. This prolongs its keeping qualities. The food value remains essentially the same.



TWENTIETH CENTURY SPEED

Modern refrigerated tank cars transported by powerful steam or electric engines, have opened up new and better markets for thousands of dairy farmers who furnish our cities with fresh milk.

THE GREAT WHITE FLEET

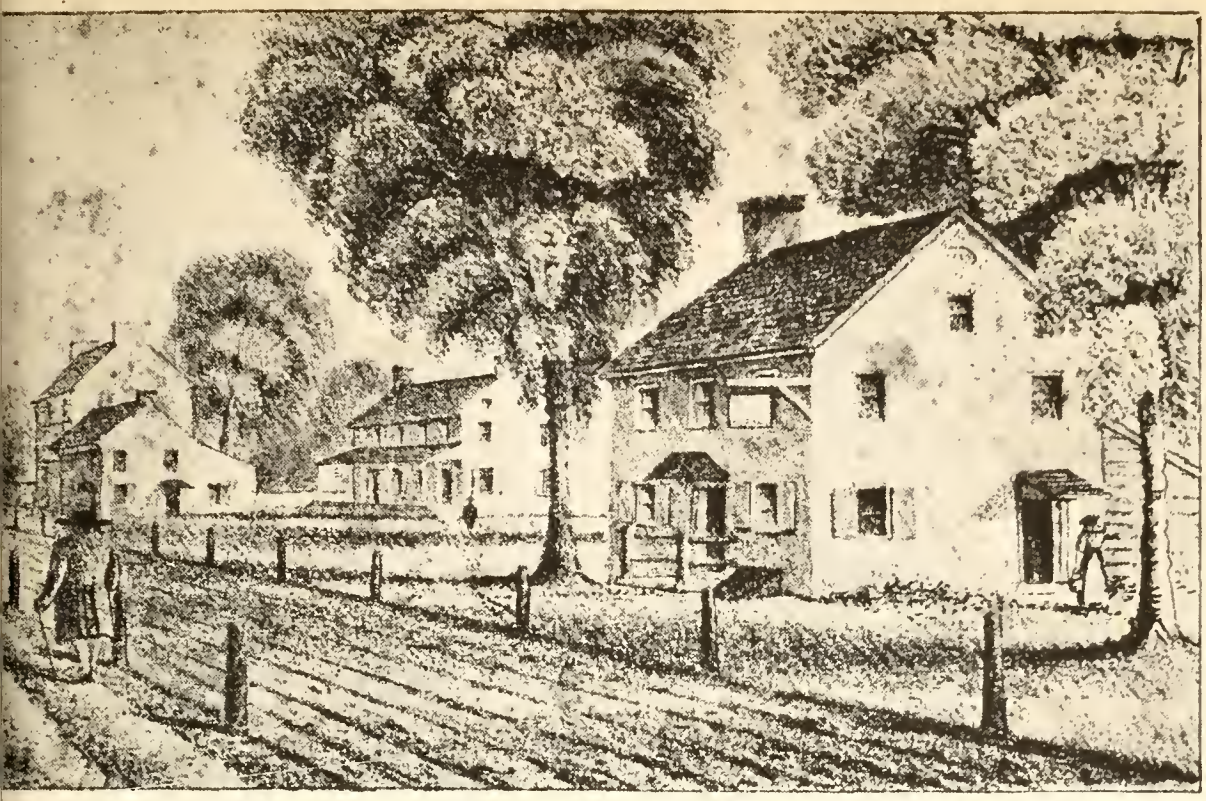
Special milk tank trucks now supplement tank cars for shorter hauling distances. This great white fleet of insulated tank trucks plys between country and city in all types of weather. In storms their route is the first opened by snow plows.

THE IRON HORSE

The steam engine opened new doors in transportation. The first attempt to ship milk by train was into Boston about 1839. It became a successful practice only after many patient efforts to transport so perishable a food as milk.

BEFORE TANK CARS

For many years, cans were loaded into box cars and thus transported to the city market. This method has been gradually displaced by a specialized type of tank car or truck.



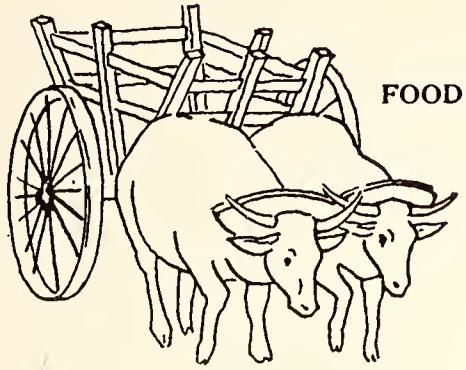
WHEN CITIES WERE VILLAGES

A hundred and fifty years ago each home had its own cow, garden, and fruit trees. This street of Philadelphia, opposite Independence Hall, today is a crowded thoroughfare whose occupants depend upon a transported food supply.

BY HORSE AND BUGGY

As villages have gradually grown into cities, farming districts have been pushed farther and farther away. Distances have thus become too great for milk to be delivered by most farmers to the consumer's door.

WHAT MAKES THEM GO?
WHEELS—A Symbol of POWER

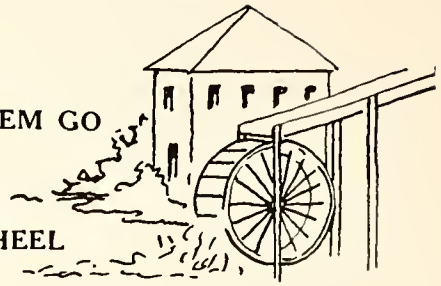


FOOD MAKES OXEN GO

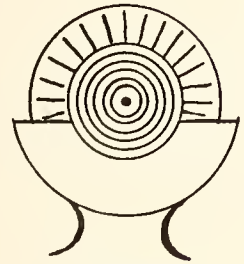
OX-CART

EARLY WHEELS

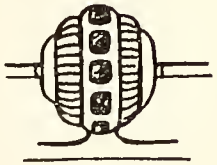
WATER MADE THEM GO



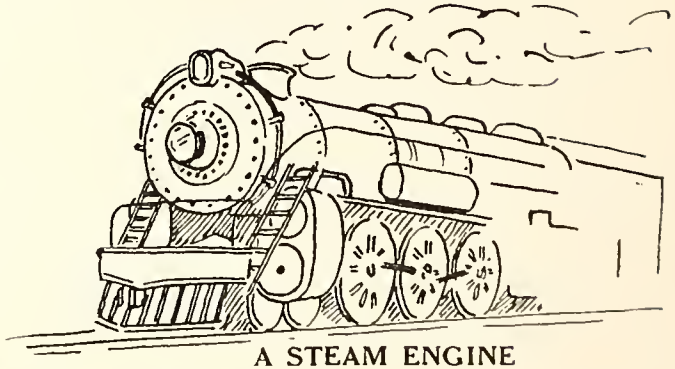
A WATER WHEEL



TURBINE
MODERN WATER WHEEL



DYNAMO

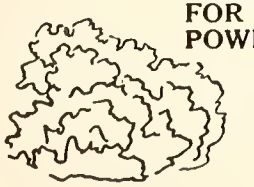


A STEAM ENGINE
THE POWER IN COAL MAKES THEM GO

FOOD POWER

MEASURED AS CALORIES. MAN GETS HIS POWER INDIRECTLY FROM THE SUN THROUGH THE FOODS HE EATS. MILK, GREEN VEGETABLES AND FRUITS ARE HIGH SCORE FOODS

PLANTS THAT WORK FOR US GET THEIR POWER FROM THE SUN

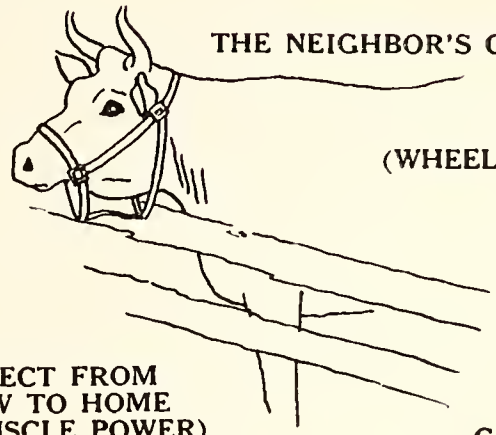


ANIMALS THAT WORK FOR US DEPEND ON THE PLANT FACTORY

TRANSPORTATION

A. LONG AGO

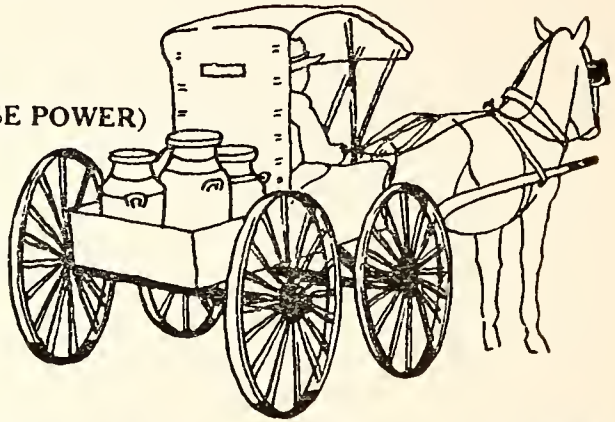
THE NEIGHBOR'S COW



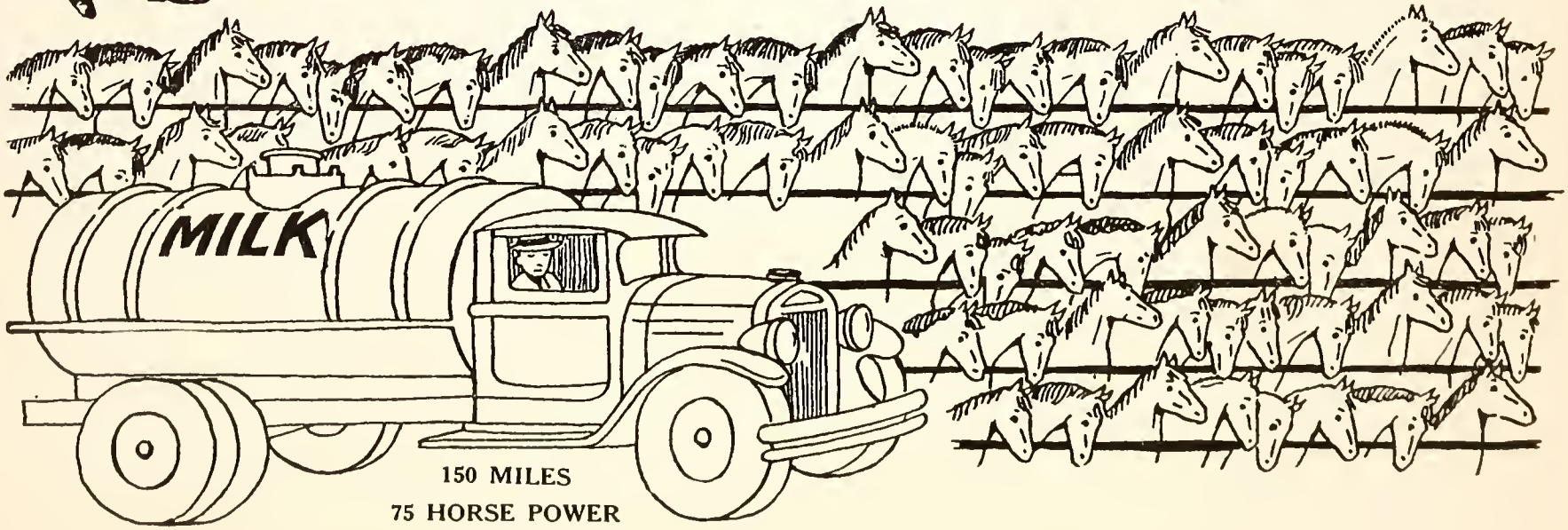
DIRECT FROM
COW TO HOME
(MUSCLE POWER)

B. YESTERDAY

A FEW MILES
(WHEELS AND ONE HORSE POWER)



C. TODAY



150 MILES
75 HORSE POWER

The STORY of MILK

6. MILK - the FOOD

637.1
P53s

Contents: Section VI

No. 1. Forward to the teacher.
2. A diet of milk, fruit, vegetables, eggs and whole grained cereals. (Diagram).
Series VI-1 to VI-6 Photos describing text.

there are 2 copies VI-2 photos but VI-4 missing 11-2-51

Foreword to the Teacher

We think of the source of milk vaguely as being "the farm" or "the cow." But beyond the cow with her definite food needs is the plant she eats. Beyond the plant with its equally definite food needs lies the soil—the source of all food.

In the soil are calcium and the other minerals necessary for our well being. But neither we nor the animals can utilize these minerals as they exist in the soil.

The necessary minerals of our own food supply are elaborated for us in a series of marvellous steps. Out of the soil which has been built up through countless millions of years, the plant manufactures from inorganic rock particles, organic food for the cow. The cow, in a second marvellous process, converts these elements into their highest form—milk.

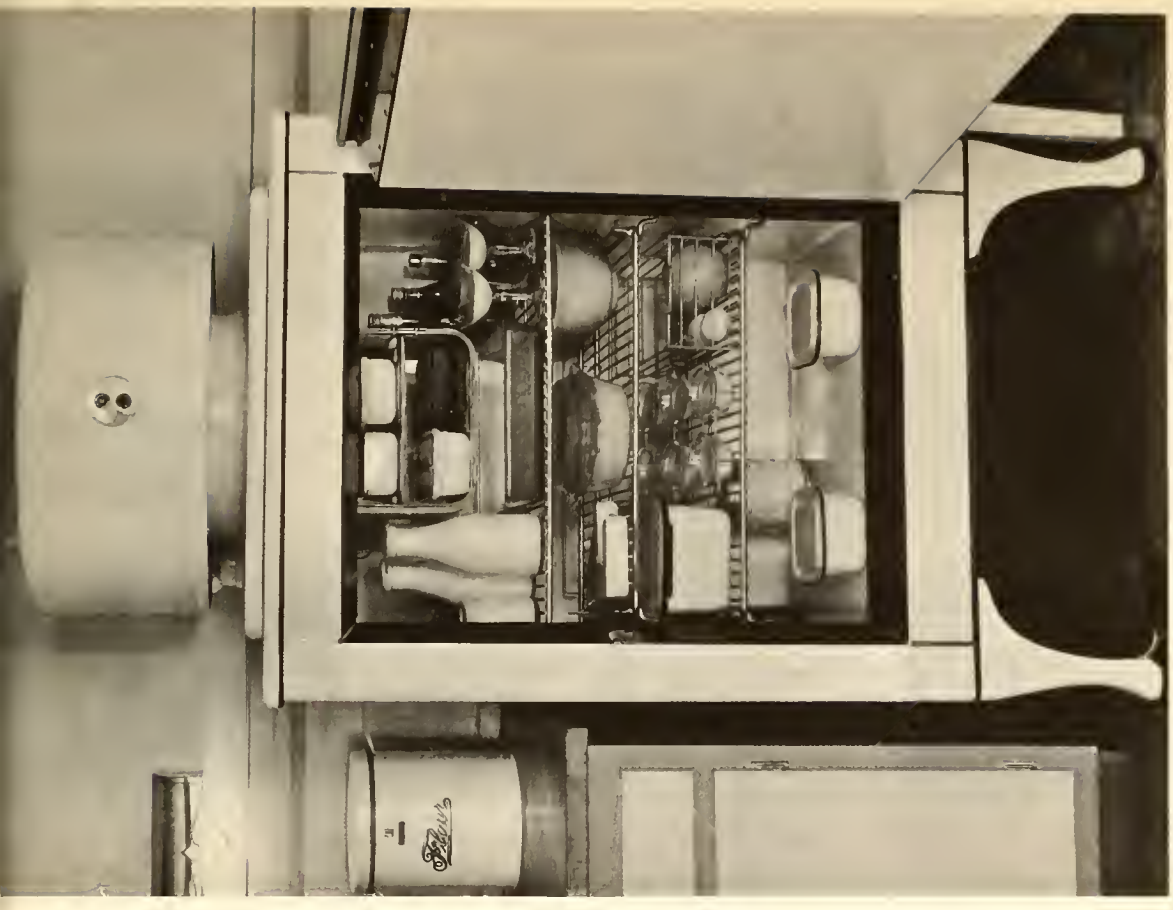
This is the story of milk, then, through its successive phases. The subject is full of unexplored possibilities. The material is presented with as much flexibility as possible in order that the teacher may organize it to suit the needs of the individual student group.

The material is assembled under the following topics: 1—Rocks and Soil; 2—The Growing Plant; 3—The Cow; 4—The Dairy Farm; 5—Transportation and Distribution; 6—Milk, the Food. Each topic is presented in a separate folder.

PUBLISHED BY THE DAIRY COUNCIL

A DIET OF MILK, FRUIT, VEGETABLES, EGGS AND WHOLE GRAINED CEREALS

MILK HAS ONE OF THE FINEST PROTEINS KNOWN. MILK IS THE ONLY PROTEIN FOOD THAT ALSO SUPPLIES AN ADEQUATE AMOUNT OF CALCIUM. CALCIUM AND PHOSPHATE ARE IN EXCELLENT PROPORTIONS.



THE CARE OF MILK

Milk is Nature's greatest achievement in food. From rocks to soil; from plant to cow; from the farm to home, it arrives valuable and highly perishable. Keep it cool and use it at every meal.

WAYS TO COOK WITH MILK

It is not difficult to eat a quart of milk a day. Many prefer to drink it. Others put it in cocoa or other hot and cold drinks, souffles, cereals cooked in milk, scallops, cream soups or custards.

3⅓ oz. Carrots
2 Oranges (Small)
10 oz. Tomato Juice
5 oz. Cabbage
2½ oz. Potato
1 Tomato
5 Prunes
¼ oz. Cheese
⅔ oz. Oatmeal
3½ oz. Onions
⅓ Egg Yolk
1 Thin W. Wheat Bread
⅛ c. Salmon
½ c. Milk
½ Shredded Wheat

ONE SHARE EACH OF PHOSPHORUS

Milk is a good source of phosphorus. Amounts of foods shown give one share each of this mineral, and the human body needs thirty shares each day.

1 Large Onion
2 Medium Oranges
1 Tomato
1 oz. Peas
2½ oz. Lettuce
¼ oz. Molasses
½ oz. Oatmeal
½ oz. Prunes
⅓ Egg
1 Whole Wheat Bread
10 oz. Milk
½ oz. Spinach

THE IRON IN MILK

Each food above furnishes one share of iron. Milk is low in quantity of iron but high in quality. A good combination for quantity and quality is whole wheat bread and milk.

SERIES VI—6
P. I. D. C.

THE WHITE RAT'S CONTRIBUTION TO SCIENCE

An inestimable contribution has been made by the white rat to the science of nutrition. Since he lives thirty times faster than the human it is possible to study the effects of diets on many generations

AN ACHIEVEMENT IN NUTRITION

A beautiful set of teeth is an achievement in nutrition. Enamel is the hardest tissue in the entire human body, and necessitates quantities of calcium besides other elements. Milk is our best source of calcium both for quantity and for quality.

MILK IS GOOD

Attitudes are formed by early childhood experiences. A heritage of finer bodies for future generations is being established. It is extremely valuable to like milk.

REPRINTED FROM "BETTER HOMES AND GARDENS"

INTO THE FUTURE

Children today, adults tomorrow! What the future holds in growth, vitality and endurance depends to a great extent on the food they eat—the quality, the quantity and the right kind to meet all of their many needs.

10 oz. Carrots
5 Apples
3½ oz. String Beans
1 oz. Bacon
½ oz. Beef
½ oz. Lamb (½ oz.)
½ oz. Cottage Cheese
5 oz. Cabbage
1 Egg Yolk
⅓ cup Milk
½ oz. Cheese
1 oz. W. Wheat Bread

MILK, AN EXCELLENT PROTEIN

One-tenth of your diet should be protein foods. The foods here each supply one share protein. Approximately thirty shares are needed each day.

1 tbsp. Milk
1 Egg Yolk
½ tbsp. Cheese
1⅔ c. Canned Corn
2 oz. Lettuce
2 Pears
1 Large Peach
7 oz. Lean Beef
2 Small Potatoes
2½ oz. Carrots

MILK, OUR BEST SOURCE OF CALCIUM

The foods shown above each supply one share of calcium. Milk calcium is the best utilized. It would be difficult to secure enough calcium without milk.

10 oz. Carrots
5 Apples
3½ oz. String Beans
1 oz. Bacon
½ oz. Beef
½ oz. Lamb (½ oz.)
½ oz. Cottage Cheese
5 oz. Cabbage
1 Egg Yolk
⅓ cup Milk
½ oz. Cheese
1 oz. W. Wheat Bread

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1 tbsp. Milk
1 Egg Yolk
½ tbsp. Cheese
1⅔ c. Canned Corn
2 oz. Lettuce
2 Pears
1 Large Peach
7 oz. Lean Beef
2 Small Potatoes
2½ oz. Carrots

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